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A TWO-CONSTITUENT SOLUTE-TRANSPORT MODEL FOR GROUND WATER HAVING VARIABLE DENSITY

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 85—4279

A TWO-CONSTITUENT SOLUTE-TRANSPORT MODEL FOR GROUND WATER HAVING VARIABLE DENSITY

by Ward E. Sanford and Leonard F. Konikow

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 85—4279
1985

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CONVERSION FACTORS

For use of readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply	By	To Obtain
foot (ft)	0.3048	meter (m)
square foot (ft^2)	0.0929	square meter (m^2)
square foot per second (ft^2/s)	929.0	square centimeter per second (cm^2/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
pound (lb)	4.448	newton (N)
pound per square foot (lb/ft^2)	47.88	pascal or newton per meter squared (Pa or N/m^2)
pound per cubic foot (lb/ft^3)	157.1	newton per cubic meter (N/m^3)

PREFACE

This report presents a digital computer model for calculating changes in the concentration of dissolved chemical species in flowing ground water. The computer program represents a basic and general model that may have to be modified by the user for efficient application to his specific field problem. Although this model will produce reliable calculations for a wide variety of field problems, the user is cautioned that in some cases the accuracy and efficiency of the model can be affected significantly by his discretization and his selection of values for certain other user-specified options.

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A TWO-CONSTITUENT SOLUTE-TRANSPORT MODEL FOR GROUND WATER HAVING VARIABLE DENSITY

By

Ward E. Sanford and Leonard F. Konikow

ABSTRACT

A numerical model has been developed to simulate solute transport and dispersion of either one or two constituents in ground water where there is two-dimensional, density-dependent flow. The model is a modified version of the one documented by Konikow and Bredehoeft (1978), which uses finite-difference methods and the method of characteristics to solve the flow and transport equations. The model was tested on an idealized seawater-intrusion problem for which Henry (1964) developed an analytical solution. The results were nearly identical to those of other numerical models tested on the same problem. A description of the formats for the input data, a sample of input and output for a two-constituent example problem, and a listing of the Fortran program are presented.

INTRODUCTION

Various numerical models have recently been developed that simulate ground-water flow and solute transport for a variety of conditions. Some of the available models are designed to simulate the flow of ground water that has a constant and uniform fluid density, and others can simulate variable density fluids in which the concentration of the solute of interest affects the density of the fluid. The latter models typically have been applied to problems of seawater intrusion in coastal aquifers. However, there are many problems in which contaminants are introduced into an aquifer near the interface or transition zone between freshwater and saltwater. Examples include the injection of waste water into coastal aquifers; Burnham and others (1977), Larson and others (1977), and Rosenshein and Hickey (1977) describe such practices in Hawaii and Florida. In such cases the injection will affect the fluid pressure and flow of both the freshwater and saltwater, but the contaminants being injected are generally in such low concentrations that changes in concentration of the contaminants will not affect the fluid density. Simulation of such problems thus requires the ability to simulate the simultaneous flow of variable-density ground water and the transport and dispersion of at least two solutes or soluble constituents. The fluid density needs to be related to the concentration of one of the constituents, which in practice can be either salinity, dissolved-solids concentration, specific conductance, or chloride concentration. The objective of this report is to document a numerical simulation model that is applicable to these types of problems.

The model described in this report is a modified version of the ground-water flow and solute-transport model of Konikow and Bredehoeft (1978), which was designed to simulate the transport and dispersion of a single solute that does not affect the fluid density. This modified version simulates the flow in a cross-sectional plane rather than in an areal plane. Because the problem of interest involves variable density, the modified model solves for fluid pressure rather than hydraulic head in the flow equation; the solution to the flow equation is still obtained using a finite-difference method. Solute transport is simulated with the method of characteristics as in the original model. Density is considered to be a function of the concentration of one of the constituents. Use of this model depends on assumptions that (1) flow is two-dimensional, with one of the principal axes being parallel to gravity, (2) constituents are conservative (nonreactive), and (3) density and viscosity are a function of concentration and not of other factors such as pressure and temperature. These assumptions are often valid approximations where an aquifer system contains both freshwater and saltwater. This model is applicable in such situations where, in addition to that of the density-controlling species, the movement and concentration of another chemical species, such as a dissolved pollutant, needs to be predicted. The model is also applicable to a two-constituent system with no density-dependence, given that the other assumptions are valid, and to a single-constituent system with variable density. This model documentation needs to be used in conjunction with the original documentation of Konikow and Bredehoeft (1978) because many of the detailed descriptions of theory, numerical methods, and program features and options contained in the original documentation are not repeated in this report.

Acknowledgments

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THEORY

The model solves an equation which represents the flow of a compressible fluid through a heterogeneous, anisotropic, confined aquifer. By following the developments of Cooper (1966) and of Bredehoeft and Pinder (1973), the general flow equation can be expressed in cartesian tensor notation as:

$$\frac{\partial}{\partial x_i}\left[\frac{\rho g k_{ij}}{\mu}\left(\frac{\partial P}{\partial x_i} + \rho g \frac{\partial z^*}{\partial x_j}\right)\right] = S_s \frac{\partial P}{\partial t} + W^* \rho^* g \qquad i,j=1,2 \qquad (1)$$

where k_{ij} is the intrinsic permeability (a second-order tensor), L^2;

ρ is the fluid density, ML^{-3};

μ is the dynamic viscosity, $ML^{-1}T^{-1}$;

P is the fluid pressure, $ML^{-1}T^{-2}$;

g is the gravitational acceleration constant, LT^{-2};

z^* is the elevation of the reference point above a standard datum, L;

S_s is the specific storage of the aquifer, L^{-1};

$W^*=W^*(x,y,z,t)$ is a source/sink volume flux per unit volume (positive sign for outflow and negative or inflow), T^{-1};

ρ^* is the density of the source/sink fluid, ML^{-3};

x_i are the cartesian coordinates, L; and

t is the time, T.

The source/sink term is handled with the method used by Konikow and Bredehoeft (1978) but is written in terms of pressure, as follows:

$$W^*(x,y,z,t) = \frac{Q^*(x,y,z,t)}{\Delta x \Delta y \Delta z} - \frac{k_z}{\mu m \Delta z}\left(P_s - P + \rho g(z_s - z^*)\right) \qquad (2)$$

where $Q^*(x,y,z,t)$ is the rate of withdrawal (positive sign) or recharge (negative sign), T^{-1};

k_z is the vertical permeability of the confining layer, L^2;

m is the thickness of the confining layer, L;

Δy is the width of the aquifer cross-section, L;

Δx and Δz are the grid dimensions in the x and z directions, respectively, L;

P_s is the fluid pressure in the source bed, $ML^{-1}T^{-2}$; and

z_s is the elevation of the source bed above a standard datum, L.

The second term on the right side of equation two can be used to represent steady leakage through a confining bed, which would only be applicable along a boundary node, or to represent a constant-pressure boundary condition, as explained in more detail below.

The equations that represent solute transport and dispersion are also solved in this model. Based on the work of Pinder and Cooper (1970), Bear (1972), Bredehoeft and Pinder (1973), and Konikow and Grove (1977), the equation for transport and dispersion of solutes in flowing

ground water in cartesian tensor notation can be written:

$$\frac{\partial C_n}{\partial t} = \frac{\partial}{\partial x_i}\left(D_{ij} \frac{\partial C_n}{\partial x_i} \right) - \frac{\partial}{\partial x_i}(C_n V_i) - \frac{C_n' W^*}{\epsilon} \qquad (3)$$

where D_{ij} is the coefficient of hydrodynamic dispersion (a second-order tensor), L^2T^{-1};

V_i is the seepage velocity in the direction of x_i, LT^{-1};

C_n is the concentration of the n^{th} constituent, ML^{-3};

C_n' is the concentration of the n^{th} constituent in the source or sink fluid, ML^{-3}; and

ϵ is the effective porosity (dimensionless).

Two constituents are represented in this model, so n=1,2 in equation 3, giving two similar equations, one for each constituent. The density and viscosity are taken to be a linear function of the concentration of the first constituent, C_1, as follows:

$$\rho_{(i,j)} = A_d C_{1(i,j)} + B_d \qquad (4)$$

$$\mu(i,j) = A_v C_{1(i,j)} + B_v \qquad (5)$$

where A_d and B_d are the slope and intercept, respectively, for the relationship between density and solute concentration, and A_v and B_v are the slope and intercept, respectively for the relationship between viscosity and solute concentration. The user has the option of specifying values for these coefficients, or else using default values built into the model for salinity or dissolved-solids concentration. The default values, based on data from Weast (1981, p. D-229) for seawater at different salinities (in parts per million, or ppm), are $A_d = 4.743 \times 10^{-5}$,

$B_d = 62.43$, $A_v = 3.45 \times 10^{-11}$ and $B_v = 2.089 \times 10^{-5}$ for $C_l < 20{,}000$ ppm, and $A_v = 4.733 \times 10^{-11}$ and $B_v = 2.063 \times 10^{-5}$ for $C_l > 20{,}000$ ppm.

The coefficient of hydrodynamic dispersion represents the sum of the mechanical dispersion, which depends upon both the flow of the fluid and the nature of the pore system, and the molecular and ionic diffusion. These terms can be represented as:

$$D_{ij} = \alpha_{ijmm} \frac{V_m V_n}{|V|} + D_m \tag{6}$$

where D_m is the coefficient of molecular and ionic diffusion, L^2T^{-1};

α_{ijmn} is the dispersivity of the aquifer, L;

V_m and V_n are components of velocity in the m and n directions, respectively, LT^{-1}; and

$|V|$ is the magnitude of the velocity, LT^{-1}.

Scheidegger (1961) further shows that for an isotropic aquifer the dispersivity tensor can be defined in terms of two constants. These are the longitudinal and transverse dispersivities of the aquifer (α_L and α_T, respectively). These are related to the longitudinal and transverse dispersion coefficients by:

$$D_L = \alpha_L |V| \tag{7}$$

$$D_T = \alpha_T |V| \tag{8}$$

Based on the work of Scheidegger (1961) and Bear (1972), we may state explicitly the components of the dispersion coefficients for two-dimensional flow in an isotropic aquifer as:

$$D_{xx} = D_L \frac{(V_x)^2}{|V|^2} + D_T \frac{(V_z)^2}{|V|^2} + D_m \quad (9)$$

$$D_{zz} = D_T \frac{(V_x)^2}{|V|^2} + D_L \frac{(V_z)^2}{|V|^2} + D_m \quad (10)$$

$$D_{xz} = D_{zx} = (D_L - D_T) \frac{V_x V_z}{|V|^2} \quad (11)$$

The seepage velocity is calculated from the solution to the flow equation using a form of Darcy's law, as described in Konikow and Grove (1977). The equation can be written in cartesian tensor notation as:

$$V_i = \frac{-k_{ij}}{\varepsilon\mu} \left(\frac{\partial P}{\partial x_i} + \rho g \frac{\partial z^*}{\partial x_j} \right) \quad (12)$$

NUMERICAL METHODS

The numerical methods used to solve the flow and transport equations in this model are similar to those used in the original model by Konikow and Bredehoeft (1978). An iterative finite-difference scheme that uses a strongly implicit procedure (see Trescott and others, 1976) is used to solve for the flow field (equation 1). The method of characteristics is used to solve for the convective (or advective) part of the transport (equation 3), while an explicit finite-difference scheme is used to solve for dispersion. Some of the additions described below were made to improve the performance and applicability of the original 1978 model. Further additions and modifications were made to provide the capability to simulate two constituents and variable density.

The method of characteristics uses particle-tracking to simulate the advection of the solute of interest. In the 1978 version, the user could specify 4, 5, 8, or 9 particles to be generated per node. The first addition made to the original model was to allow 16 particles per node to be specified in order to improve numerical accuracy. As a second addition, molecular diffusion was added to the term describing hydrodynamic dispersion in the solute-transport equation (molecular diffusion had been assumed to be negligible in the original model). This change was necessary to allow a comparison of the model results for a variable-density problem with the analytical solution developed by Henry (1964). Corresponding modifications were then included in the finite-difference scheme that represents dispersion by adding a diffusion constant to the dispersion terms, as shown by equations 9-11. A third minor modification was made that allows the user to specify the maximum number of cells that can be void of tracer particles (NZCRIT). If NZCRIT is exceeded, the particle locations are reinitialized. Fourth, the maximum dimensions of all two-dimensional arrays were increased to (24,20) from the original (20,20). The fifth addition was the introduction of a particle-weighting (or fractional particle) scheme that allows weak sources and sinks to be more accurately represented. In this scheme, particles generated initially at all nodes receive a weight of one. Particles that are later regenerated or removed at sources and sinks are given a weight from zero to one, which represents the fraction of fluid passing through the block that is due to the presence of the source or sink. In effect, particles are weighted in proportion to fluid volumes. This particle-weighting scheme significantly improves the chemical mass

balance in the model, especially if the fluid in the source or sink only accounts for a small fraction of the fluid passing through the block.

Additional modifications have been made to the model to allow for cross-sectional, density-dependent flow and the transport and dispersion of two constituents. The general flow equation described in equations 1 and 2 can be written together in the following finite-difference form:

$$\left[\frac{\rho g k_{xx}}{\mu}\right]_{(i-\frac{1}{2},j)}\left[\frac{P_{i-1,j,k} - P_{i,j,k}}{(\Delta x)^2}\right] + \left[\frac{\rho g k_{xx}}{\mu}\right]_{(i+\frac{1}{2},j)}\left[\frac{P_{i+1,j,k} - P_{i,j,k}}{(\Delta x)^2}\right]$$

$$+ \left[\frac{\rho g k_{zz}}{\mu}\right]_{(i,j-\frac{1}{2})}\left[\frac{P_{i,j-1,k} - P_{i,j,k}}{(\Delta z)^2} + \frac{(\rho g)_{i,j-\frac{1}{2}}}{\Delta z}\right]$$

$$+ \left[\frac{\rho g k_{zz}}{\mu}\right]_{(i,j+\frac{1}{2})}\left[\frac{P_{i,j+1,k} - P_{i,j,k}}{(\Delta z)^2} + \frac{(\rho g)_{i,j+\frac{1}{2}}}{\Delta z}\right]$$

$$= S_s\left[\frac{P_{i,j,k} - P_{i,j,k-1}}{\Delta t}\right] + \left[\frac{\rho g q_w}{\Delta x \Delta y \Delta z}\right]_{(i,j)}$$

$$+ \left[\frac{\rho g k_z}{\Delta z \mu m}\right]_{(i,j)}\left[P_{s(i,j)} - P_{i,j} + [\rho g]_{i,j}[z_s - z^*]\right] \qquad (13)$$

where i,j,k are the indices in the x, z, and time dimensions, respectively; and

q_w is the volumetric rate of withdrawal or recharge at the (i,j) node, L^3T^{-1}.

The modifications for the solution of the flow equation thus include (1) solving for fluid pressure rather than hydraulic head, (2) using density, viscosity, and intrinsic permeability rather than hydraulic conductivity, (3) using specific storage rather than storage coefficient to represent

storativity, and (4) using a constant aquifer width rather than a variable thickness to represent the third dimension.

Constant-pressure boundaries are treated in the same basic way as in Konikow and Bredehoeft (1978). This approach is based on the principle that as the leakance coefficient of the confining bed (that is, its conductance, defined as the hydraulic conductivity of the confining layer divided by the thickness of the confining layer) increases to a sufficiently high value, the difference in head across the confining bed will decrease to a negligible value so that the heads will be essentially identical on both sides of the confining bed. Thus, given a sufficiently high value for the leakance coefficient and a constant value of head (or pressure in this case) in the source bed, then the head (or pressure) in the aquifer at that location will always remain essentially the same as the specified constant value of head (or pressure) because the confining bed can readily transmit an adequate flux to compensate for any stresses imposed elsewhere in the aquifer. The constant-pressure term in the equation will then take on virtually the same form as the constant-head term in the original model. However, if the leakance coefficient is specified as too high a value relative to the conductance within the aquifer, then although the computed value of head (or pressure) in the aquifer is the desired constant value, the head difference will be so small that numerical truncation errors may induce significant errors in the subsequent calculation of the flux at that constant-head boundary node. An error in the computed flux can have a serious effect on the accuracy of the computed solute concentrations because that flux represents part of the source term in the solute-transport equation (that is, the third term on the right side of equation 3). Therefore, the

original model, which required the user to specify the head and the leakance coefficient at a constant-head node, was modified to allow the user to specify only the desired constant-pressure value. The model then automatically calculates a value of the leakance coefficient that is ten orders of magnitude greater than the conductance of the aquifer at that location; this ratio of 10^{10} was found optimal both in providing the desired constant pressure and in eliminating serious numerical truncation error in the calculation of the flux due to leakage.

Modifications were also made to account for an additional constituent. Only one set of particles is tracked, as in the original method of characteristics, but each particle is assigned two independent concentration values. The finite-difference equations that represent the dispersion, which are presented in detail by Konikow and Bredehoeft (1978), are now solved twice, once for each constituent.

The flow equation and the solute-transport equation are coupled by allowing the density and viscosity to be a function of the concentration of the first constituent. In this model, particles are moved in time steps whose lengths are determined by certain stability criteria (see Konikow and Bredehoeft, 1978). After every movement of all particles is completed, the new model checks to see if a concentration change has occurred that would significantly affect the density. If a significant change in concentration has occurred, the pressures are recalculated using the new densities. In this way, the calculated flow field is periodically updated to account for changes in density due to changes in concentration. The criteria defining the amount of change that is considered significant is specified by the user in the input data.

MODEL VERIFICATION

One way to test the accuracy of a numerical model is to compare its results with that of a known analytical solution. Konikow and Bredehoeft (1978) compared the numerical results with analytical solutions for dispersion in one-dimensional steady flow and in plane radial steady flow, in both cases assuming constant fluid density. Their results demonstrated that the model is numerically accurate for these conditions.

For the case of variable-density fluids this model was tested on a problem for which an analytical solution was developed by Henry (1964). The problem was set up with boundary conditions and parameters (as shown in fig. 1) that allowed for the convergence of the infinite series involved in Henry'solution. A constant flux, Q, on the left side of the system balances a tongue of saltwater entering from the right, which gives a steady-state transition zone between freshwater and saltwater. The 0.5 isochlor in figure 1 shows the center of the transition zone.

Pinder and Cooper (1970) were one of the first to use this problem for testing a numerical model. Their parameters of $Q = 0.66$ cm^2/s, $K = 1.0$ cm/s, and $D_m = 0.066$ cm^2/s (7.10×10^{-5} ft^2/s) were used in the comparisons between other numerical models and the model being documented in this report. The analyses are further based on $C_s = 35{,}000$ mg/L and $\rho_s = 1.025$ g/cm^3, where C_s is the concentration of salt in seawater and ρ_s is the density of seawater.

A direct comparison was not made with Henry's analytical solution, which requires letting the system run to steady state after beginning with some fixed concentration. Also, the right hand boundary condition in

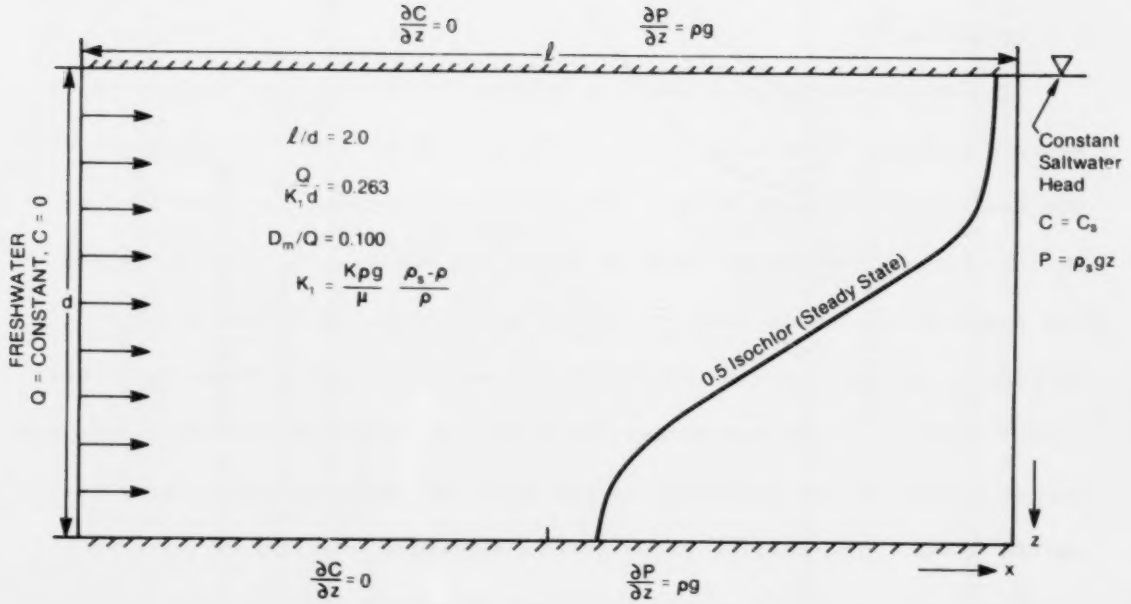

Figure 1. Parameters, Boundary Conditions, and Solution of Henry's Problem (Henry, 1964)

Henry's problem is unrealistic for a system that a numerical model would be simulating. Fluid is exiting the system at the top right, but Henry's solution allows diffusion to occur back across the boundary. For these reasons, the comparison was made with the results from other numerical models that solved Henry's problem for 100 minutes (simulation time) and allowed no backward diffusion across the boundary. The first comparison was with the results from a finite-element model of Segol and others (1975). As seen in figure 2, the 0.5 isochlors from the two models are at virtually the same location. Note that the 0.5 isochlor is equivalent to C = 17,500 mg/L.

The finite-difference model by INTERA (1979) was also used to solve Henry's problem. The comparison in figure 3 shows that the isochlors from the two models are very close. The difference between the positions of the isochlors from the solution of Segol and others (1975) (fig. 2) and the positions of those from the INTERA model (fig. 3) is due to a difference in the value of the diffusion constant used. Segol and others (1975) apparently did not divide the diffusion constant used in Pinder and Cooper (1970) by the porosity, as was done for the simulation using the INTERA model. The smaller value of the diffusion coefficient used by Segol and others (1975) caused the front to move further to the left. Both results show that the model being documented in this report gives results comparable to those of other numerical models used on a problem for which an analytical solution is known. The results obtained with this model for the problems shown in figures 2 and 3 are also essentially identical to those obtained by Voss (1984) using a finite-element model for the same two problems.

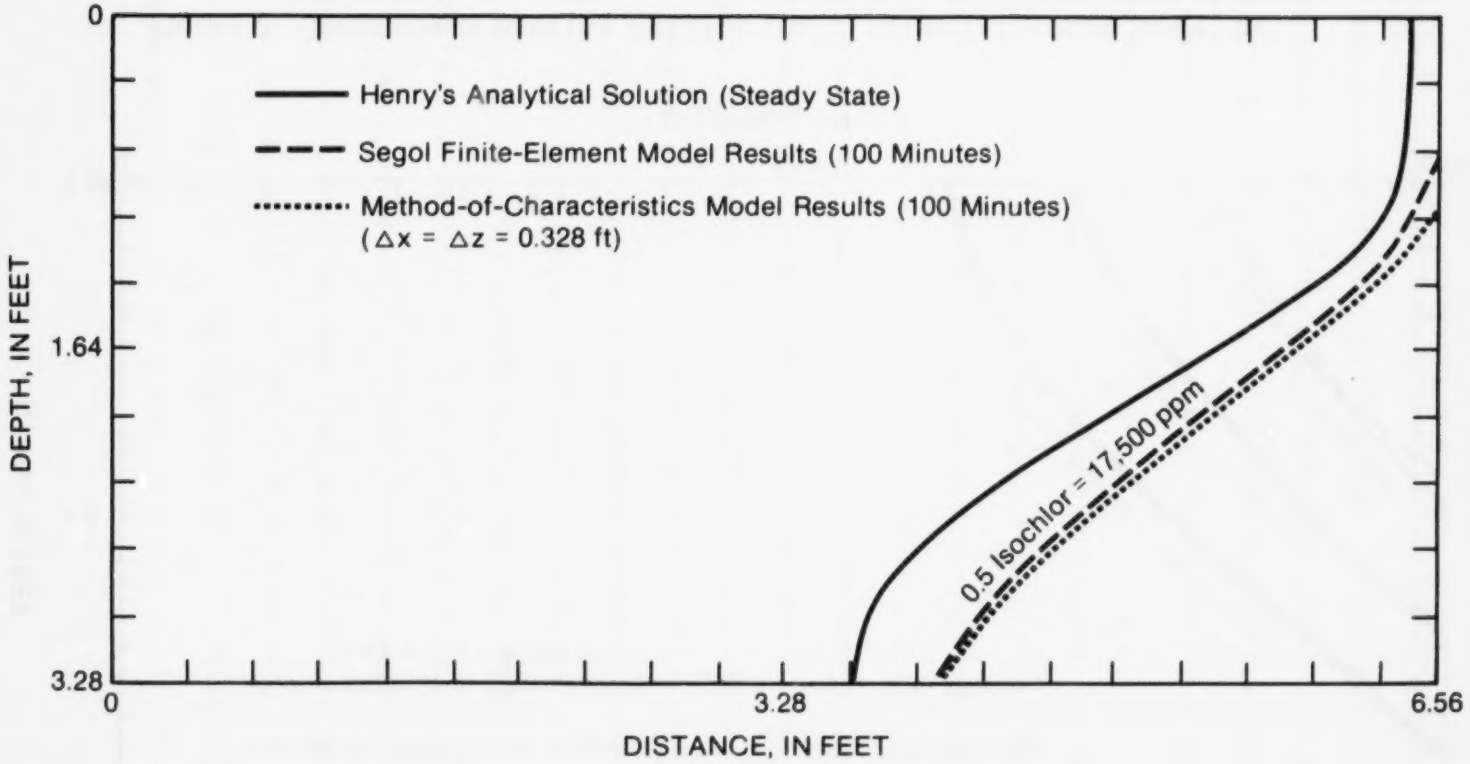

Figure 2. Comparison with Segol's Model for Henry's Problem ($D_m = 7.10 \times 10^{-5}\ ft^2/s$ in Both Numerical Models).

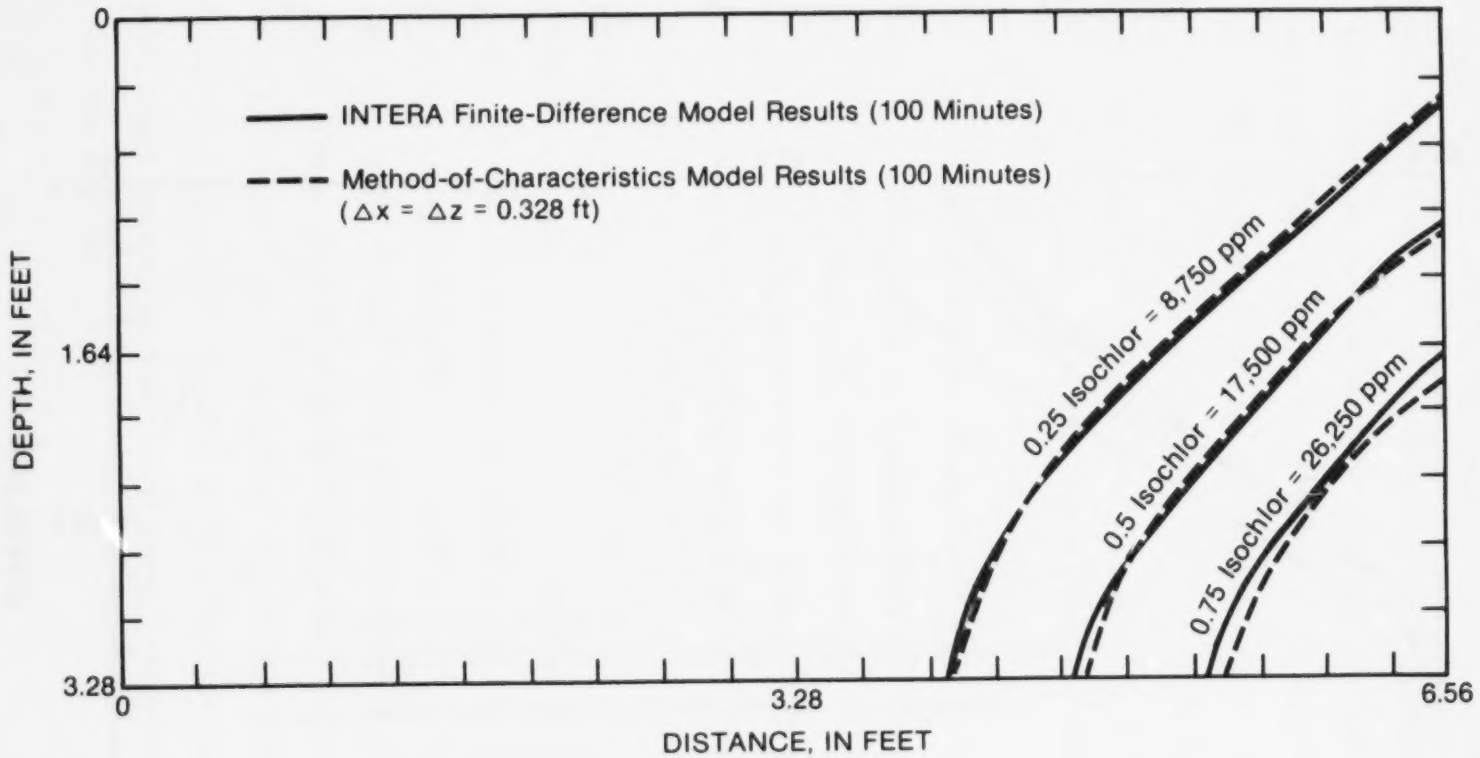

Figure 3. Comparison With the INTERA (1979) Finite-Difference Model for Henry's Problem (D_m = 2.03 x 10^{-4} ft^2/s in Both Numerical Models).

USER'S GUIDE

The input and output formats have been designed for flexibility of use and general compatibility with the analysis of typical problems to which the model is applicable. All input data formats are described in Appendix I. Immediately before the program is run, the input data file must be opened as unit 5 of the computer system and the output file must be opened as unit 6.

The model will allow a unique source/sink rate to be specified at each node, and will allow up to five observation points to be specified for summary printouts of concentration and pressure versus time. The program also includes a node identification array (NODEID), which allows certain nodes or zones to be identified by a unique code number. This feature is used to identify constant-pressure cells. The concentration of the source fluid for each code value is then specified in data set 6. The values of the constant pressures are taken from the initial pressures specified in data set 7. Additional details and general information are presented by Konikow and Bredehoeft (1978).

Note that ε, S, THICK, WIDTH, α_L, α_T, D_m, and ANFCTR are all assumed to be constant and uniform. If it is desired to specify a different value for any of these parameters at different nodes, then these constants must be changed to arrays and the input and output formats and program statements revised accordingly. The user should also change the input/output formats when those specified do not provide enough significant figures.

A labeled listing of the input data for a sample problem is provided in Appendix II to illustrate the use of the data-input formats for the model. The sample problem is a simple approximation of a cross section through a coastal aquifer in which the freshwater part is subject to contamination (see fig. 4). The right side of the grid is specified as a constant-pressure boundary at hydrostatic saltwater pressures. The freshwater contaminant is introduced in two nodes in the upper left corner of the grid, and uncontaminated freshwater recharges through a constant-pressure boundary over the other top-row cells. This data set also illustrates that only a small data file is required to simulate a relatively simple problem.

Selected output from this sample problem is presented in Appendix III. Not all of the output is reproduced, in order to save space, but a sufficient selection is included to illustrate the type and form of the output provided by the model, as well as to allow the user to compare his output with the documented version for verification of the code.

The initial and boundary conditions for the sample problem result in the freshwater contaminant spreading through the aquifer from the upper left and saltwater moving part way into the aquifer from the right-hand boundary, especially in the deeper part of the aquifer. After the first few time steps, the mass-balance errors for both constituents are consistently less than 5 percent, which is generally acceptable. As a general guideline, execution of this sample problem used less than 1.5 minutes of CPU time on a PRIME 850 computer.

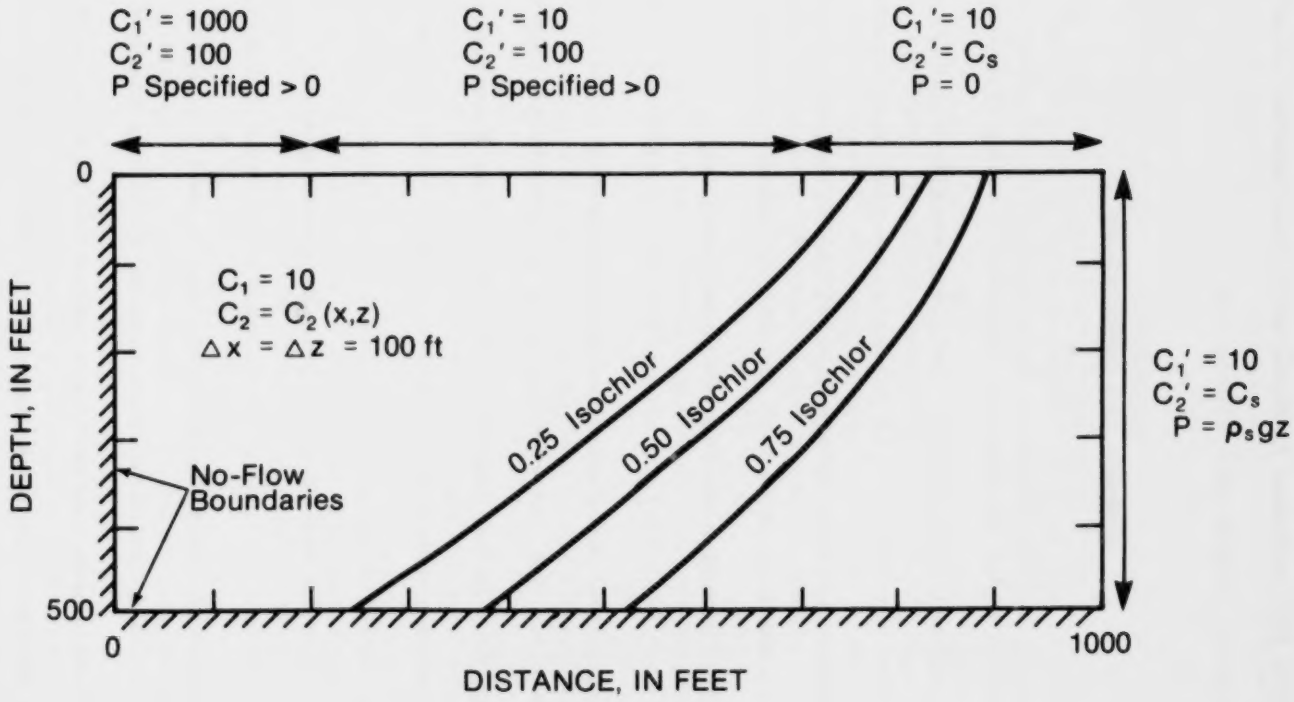

Figure 4. Initial Conditions for Sample Problem

The source code developed for this model was written in Fortran 77. The program is listed in Appendix IV and includes more than 2500 lines. For reference purposes, columns 73-80 of each line contain a label that is numbered sequentially within each subroutine.

SUMMARY AND CONCLUSIONS

For a numerical model to simulate accurately an aquifer system where both freshwater and saltwater exist, the fluid density must be considered as a variable. The introduction of contaminants into such systems requires that the concentrations of at least two dissolved species be represented in a numerical transport simulation model -- one concentration affecting the fluid density and the other representing a contaminant. The model described here will perform such numerical simulations. The model is a modification of the one documented by Konikow and Bredehoeft (1978) in which the equations and numerical methods were modified to represent density-dependent flow and transport of two dissolved constituents in a cross-sectional plane. Other modifications made to the original model include adding a 16-particle-per-cell option, a molecular diffusion option, and the introduction of a particle-weighting scheme.

The variable-density aspects of the model were tested on a problem for which an analytical solution was developed by Henry (1964). The results closely matched the documented results from other numerical models. Therefore, these results, in combination with the previous documentation by Konikow and Bredehoeft (1978) of their model's

applicability to constant-density problems, indicate that this new model can be applied to problems involving density-dependent flow and transport of two solutes in a ground-water system.

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APPENDIX I: INPUT DATA SPECIFICATIONS

Line	*Column*	*Format*	*Variable*	*Definition*
1	1-80	10A8	TITLE	Description of problem.
2	1- 4	I4	NTIM	Maximum number of time steps in a pumping period (limit=100)*.
	5- 8	I4	NPMP	Number of pumping periods. Note that if NPMP>1, then data set 11 must be completed.
	9-12	I4	NX	Number of nodes in x direction (limit=24)*.
	13-16	I4	NZ	Number of nodes in z direction (limit=20)*.
	17-20	I4	NPMAX	Maximum number of particles (limit=6400)*.
	21-24	I4	NPNT	Time-step interval for printing hydraulic and chemical output data.
	25-28	I4	NUMOBS	Number of observation points to be specified in a following data set (limit=5)*.
	29-32	I4	ITMAX	Maximum allowable number of iterations in SIP (usually 100≤ITMAX≤200).
	33-36	I4	NREC	Number of pumping or injection wells to be specified in a following data set.
	37-40	I4	NPTPND	Initial number of particles per node (options=4,5,8,9,16).
	41-44	I4	NCODES	Number of node identification codes to be specified in a following data set (limit=10)*.
	45-48	I4	NZCRIT	Maximum number of cells that can be void of particles before particles are redistributed (generally equal

See footnotes at end of table.

Line	*Column*	*Format*	*Variable*	*Definition*
				to 1 to 10 percent of the number of active cells in the grid).
	49-52	I4	NCONST	Number of constituents present (1 or 2).
	53-56	I4	NPNTMV	Particle movement interval (IMOV) for printing chemical output data. (Specify 0 to print only at end of time steps.)
	57-60	I4	NPNTVL	Options for printing computed velocities (0=do not print; 1=print for first time step; 2=print for all time steps).
	61-64	I4	NPNTD	Option for printing computed dispersion equation coefficients (option definition same as for NPNTVL).
	65-68	I4	NPDELC	Option for printing computed changes in concentration (0=do not print; 1=print).
	69-72	I4	NPNCHV	Option to write velocity data in separate file (option definition same as for NPNTVL). When specified, program will write the velocities at nodes on unit 7.
3	1-10	G10.0	PINT	Pumping period in years.
	11-20	G10.0	TOL	Convergence criteria in SIP (usually TOL≤0.01).
	21-30	G10.0	POROS	Effective porosity.
	31-40	G10.0	BETA	Longitudinal dispersivity, in feet.
	41-50	G10.0	S	Storage coefficient (set S=0 for steady-flow problems).
	51-60	G10.0	TIMX	Time increment multiplier for transient flow problems. TIMX is disregarded if S=0.

Line	*Column*	*Format*	*Variable*	*Definition*
	61-70	G10.0	TINIT	Size of initial time step in seconds. TINIT is disregarded if S≠0.
4	1-10	G10.0	XDEL	Width of finite-difference cell in x direction, in feet.
	1-20	G10.0	ZDEL	Width in finite-difference cell in z direction, in feet.
	21-30	G10.0	DLTRAT	Ratio of transverse to longitudinal dispersivity.
	31-40	G10.0	CELDIS	Maximum cell distance per particle move (value between 0 and 1.0).
	41-50	G10.0	ANFCTR	Ratio of K_{zz} to K_{xx}.
	51-60	G10.0	WIDTH	Width (third dimension) of the aquifer cross-section, in feet.
	61-70	G10.0	CTOL	Concentration change increment for density-dependent constituent to determine whether pressures are recalculated.
	71-80	G10.0	DMOLEC	Molecular diffusion coefficient, in ft^2/s.

Data Set	*Number of Lines*	*Format*	*Variable*	*Definition*
1	Value of NUMOBS	2I2	IXOBS, IZOBS	x and z coordinates of observation points. This data set is eliminated if NUMOBS is specified as =0.
2	Value of NREC	2I2, 3G10.2	IX,IZ, REC, CNREC, TDSREC	x and z coordinates of pumping (+) or injection (-) wells, rate in ft^3/s, and if an injection well, the concentration in the injected water of the trace constituent, which does not affect density

Data Set	*Number of Lines*	*Format*	*Variable*	*Definition*
				(CNREC), and of the density-controlling constituent (TDSREC). This data set is eliminated if NREC=0.
3	a. 1	I1,G10.0	INPUT, FCTR	Parameter line† for PERM.
	b. Value of NZ	24G3.0	PERM	The intrinsic permeability of the aquifer, in ft^2.
4	a. 1	I1,G10.0	INPUT, FCTR	Parameter line† for VPRM.
	b. Value of NZ	24G3.0	VPRM	Leakance coefficient, in $ft^{-1}s^{-1}$.
	c. Value of NZ	24G3.0	ELEV	Elevation difference between the source bed and the aquifer node (negative if confining bed is below aquifer), in feet.
5	a. 1	I1,G10.0	INPUT, FCTR	Parameter line† for NODEID.
	b. Value of NZ	24I1	NODEID	Node identification matrix (use a nonzero value to define constant-pressure nodes).
6	Value of NCODES	I2,2G10.2	ICODE, FCTR1, FCTR2	Boundary codes and concentrations of constituents 1 and 2, respectively, in the source fluid where NODEID=ICODE.
7	a. 1	I1,G10.0	INPUT, FCTR	Parameter line† for PI.
	b. Value of NZ (double if NX>12).	12G6.0	PI	Initial fluid pressures in the aquifer, in lb/ft^2.
8	a. 1	I1,G10.0	INPUT, FCTR	Parameter card† for CONC.
	b. Value of NZ (double if NX>12).	12G6.0	CONC	Initial concentration of the trace constitutent in the aquifer. This data set is eliminated if NCONST<2.

See footnotes at end of table.

Data Set	*Number of Lines*	*Format*	*Variable*	*Definition*
9	a. 1	I1,G10.0	INPUT, FCTR	Parameter line† for TDS.
	b. Value of NZ (double if NX>12).	12G6.0	TDS	Initial concentration of the density-controlling constituent in the aquifer.
10	a. 1	I1	INPUT	Density and viscosity default parameter: 0 = yes, 1 = no.
	b. 1	4G10.3	DEN1, DEN2, VIS1, VIS2	Slopes and intercepts of linear relations between TDS and (1) density and (2) viscosity, respectively. Only read if INPUT=1 previous part a.
11				This data set allows time step parameters, print options, and pumpage data to be revised for each pumping period of the simulation. Data set 11 is only used if NPMP>1. The sequence of lines in data set 11 must be repeated (NPMP-1) times (that is, data set 11 is required for each pumping period after the first).
	a. 1	I1	ICHK	Parameter to check whether any revisions are desired. Set ICHK=1 if data are to be revised, and then complete data set 11b and c. Set ICHK=0 if data are not to be revised for the next pumping period, and skip rest of data set 11.
	b. 1	9I4,3G5.0	NTIM,NPNT, ITMAX,NREC, NPNTMV, NPNTVL, NPNTD, NPDELC, NPNCHV, PINT,TIMX, TINIT	Twelve parameters to be revised for next pumping period; the parameters were previously defined in the description of data lines 2 and 3. Only include this line if ICHK=1 in previous part a.

See footnotes at end of table.

Data Set	*Number of Lines*	*Format*	*Variable*	*Definition*
	c. Value of NREC	212,3G10.2	IX,IZ,REC, CNREC, TDSREC	Revision of previously defined data set 2. Include part c only if ICHK=1 in previous part a and if NREC>0 in previous part b.

* These limits can be modified if necessary by changing the corresponding array dimensions in the COMMON statements of the program.

† The parameter line must be the first line of the indicated data sets. It is used to specify whether the parameter is constant and uniform, and can be defined by one value, or whether it varies in space and must be defined at each node. If INPUT=0, the data set has a constant value, which is defined by FCTR. If INPUT=1, the data set is read as described by part b (and part C, if applicable) immediately following the parameter line. Then FCTR is a multiplication factor for the values read in part b of the data set.

Appendix II:

Input Data from a Sample Problem

```
LINE 1:  CROSS-SECTIONAL PROBLEM WITH VARIABLE DENSITY
LINE 2:    1   1  12   74000    1   1 100   0  16   3   5   2   1   0   0   0   0
LINE 3:         10.     .000001        0.20       100.       0.0        0.0        0.0
LINE 4:        100.       100.         1.0        0.25       1.0        100.      1000.        0.0
DATA SET 1:  7 4
DATA SET 3: 1 1.338E-11
            0  0  0  0  0  0  0  0  0  0  0  0  0
            0  1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0
            0  1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0
            0  1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0
            0  1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0
            0  1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0
            0  0  0  0  0  0  0  0  0  0  0  0  0
DATA SET 4: 0    0.0
DATA SET 5: 1     1.
            000000000000
            033222221110
            000000000010
            000000000010
            000000000010
            000000000010
            000000000000
DATA SET 6:  1   35000.    10.
             2     100.    10.
             3     100.  1000.
DATA SET 7: 1   10.0
                 0     0     0     0     0     0     0     0     0     0     0     0
                 0    65    60    50    40    30    20    10     0     0     0     0
                 0     0     0     0     0     0     0     0     0     0   641     0
                 0     0     0     0     0     0     0     0     0     0  1282     0
                 0     0     0     0     0     0     0     0     0     0  1923     0
                 0     0     0     0     0     0     0     0     0     0  2564     0
                 0     0     0     0     0     0     0     0     0     0     0     0
DATA SET 8: 0    10.0
DATA SET 9: 1    10.0
                 0     0     0     0     0     0     0     0     0     0     0     0
                 0    14    20    33    56   103   232   481   913  2573  3203     0
                 0    19    27    44    81   178   504  1051  1822  2847  3237     0
                 0    30    42    79   187   443  1175  1972  2575  3084  3314     0
                 0    47    67   135   367   951  1919  2596  2975  3263  3388     0
                 0    89   129   294   920  1554  2404  2933  3205  3367  3435     0
                 0     0     0     0     0     0     0     0     0     0     0     0
DATA SET 10: 0
```

Appendix III:

Selected Output from a Sample Problem

```
U.S.G.S. METHOD-OF-CHARACTERISTICS MODEL FOR SOLUTE TRANSPORT IN GROUND WATER

 CROSS-SECTIONAL PROBLEM WITH VARIABLE DENSITY

                I N P U T     D A T A

                  GRID DESCRIPTORS

      NX     (NUMBER OF COLUMNS)  =     12
      NZ     (NUMBER OF ROWS)     =      7
      XDEL   (X-DISTANCE IN FEET) =    100.000
      ZDEL   (Z-DISTANCE IN FEET) =    100.000
      WIDTH  (Y-DISTANCE IN FEET) =    100.000

                  TIME  PARAMETERS

      NTIM    (MAX. NO. OF TIME STEPS)        =       1
      NPMP    (NO. OF PUMPING PERIODS)        =       1
      PINT    (PUMPING PERIOD IN YEARS)       =      10.000
      TIMX    (TIME INCREMENT MULTIPLIER)     =       0.00
      TINIT   (INITIAL TIME STEP IN SEC.)     =       0.

        HYDROLOGIC AND CHEMICAL PARAMETERS

      S        (SPECIFIC STORAGE)             =       0.000000
      POROS    (EFFECTIVE POROSITY)           =       0.20
      BETA     (LONGITUDINAL DISPERSIVITY)    =     100.0
      DLTRAT   (RATIO OF TRANSVERSE TO
                LONGITUDINAL DISPERSIVITY)    =       1.00
      ANFCTR   (RATIO OF K-ZZ TO K-XX)        =       1.000000
      DMOLEC   (COEF. OF DIFFUSION)           =    0.00E-01
      NCONST   (NUMBER OF CONSTITUENTS)       =    2

                 EXECUTION PARAMETERS

      TOL      (CONVERGENCE CRITERIA - SIP)   = 0.0000010
      ITMAX    (MAX.NO.OF ITERATIONS - SIP)   =  100
      CELDIS   (MAX.CELL DISTANCE PER MOVE
                OF PARTICLES - M.O.C.)        =    0.250
      NPMAX    (MAX. NO. OF PARTICLES)        = 4000
      NPTPND   (NO. PARTICLES PER NODE)       =    16
      CTOL     (MINIMUM CONC. CHANGE
                FOR PRESSURE RECALCULATION)   = 1000.

                  PROGRAM OPTIONS

      NPNT     (TIME STEP INTERVAL FOR
                COMPLETE PRINTOUT)            =     1
      NPNTMV   (MOVE INTERVAL FOR CHEM.
                CONCENTRATION PRINTOUT)       =     1
      NPNTVL   (PRINT OPTION-VELOCITY
                0=NO; 1=FIRST TIME STEP;
                2=ALL TIME STEPS)             =     0
      NPNTD    (PRINT OPTION-DISP.COEF.
                0=NO; 1=FIRST TIME STEP;
                2=ALL TIME STEPS)             =     0
      NUMOBS   (NO. OF OBSERVATION WELLS
                FOR HYDROGRAPH PRINTOUT)      =     1
      NREC     (NO. OF RECHARGE CELLS)        =     0
      NCODES   (FOR NODE IDENT.)              =     3
      NPNCHV   (WRITE VELOCITIES-UNIT 7)      =     0
      NPDELC   (PRINT OPT.-CONC. CHANGE)      =     0
```

STEADY-STATE FLOW

TIME INTERVAL (IN SEC) FOR SOLUTE-TRANSPORT SIMULATION = 0.31558E+09

LOCATION OF OBSERVATION WELLS

NO.	X	Z
1	7	4

AREA OF ONE CELL = 0.1000E+05

X-Z SPACING:
100.00
100.00

PERMEABILITY MAP (FT**2)

0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
0.00E-01	0.00E-01								
0.00E-01	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11
1.34E-11	0.00E-01								
0.00E-01	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11
1.34E-11	0.00E-01								
0.00E-01	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11
1.34E-11	0.00E-01								
0.00E-01	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11
1.34E-11	0.00E-01								
0.00E-01	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11	1.34E-11
1.34E-11	0.00E-01								
0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
0.00E-01	0.00E-01								

NO. OF FINITE-DIFFERENCE CELLS IN AQUIFER = 50

AREA OF AQUIFER IN MODEL = 0.50000E+06 SQ. FT.

NZCRIT (MAX. NO. OF CELLS THAT CAN BE VOID OF PARTICLES; IF EXCEEDED, PARTICLES ARE REGENERATED) = 5

NODE IDENTIFICATION MAP

0	0	0	0	0	0	0	0	0	0	0	0
0	3	3	2	2	2	2	2	1	1	1	0
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0

NO. OF NODE IDENT. CODES SPECIFIED = 3

THE FOLLOWING ASSIGNMENTS HAVE BEEN MADE:

CODE NO.	TDS CONC.	CONC.
1	35000.00	10.00
2	100.00	10.00
3	100.00	1000.00

VERTICAL PERMEABILITY FACTOR (1/FT*SEC)

0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
0.00E-01	0.00E-01								
0.00E-01	1.34E-03	1.34E-03	1.34E-03	1.34E-03	1.34E-03	1.34E-03	1.34E-03	1.34E-03	1.34E-03
1.34E-03	0.00E-01								
0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
1.34E-03	0.00E-01								
0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
1.34E-03	0.00E-01								
0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
1.34E-03	0.00E-01								
0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
1.34E-03	0.00E-01								
0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
0.00E-01	0.00E-01								

INITIAL PRESSURES (LB/FT**2)

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	650.	600.	500.	400.	300.	200.	100.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	6410.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	12820.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	19230.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	25640.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

PRESSURE DISTRIBUTION - ROW
NUMBER OF TIME STEPS = 0
TIME(SECONDS) = 0.00000
TIME(DAYS) = 0.00000E-01
TIME(YEARS) = 0.00000E-01

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000								
0.0000	650.0000	600.0000	500.0000	400.0000	300.0000	200.0000	100.0000	0.0000	0.0000
0.0000	0.0000								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6410.0000	0.0000								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12820.0000	0.0000								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19230.0000	0.0000								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
25640.0000	0.0000								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000								

INITIAL CONCENTRATION MAP - TRACE SOLUTE

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	0.
0.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	0.
0.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	0.
0.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	0.
0.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

INITIAL TDS MAP - DENSITY-CONTROLLING SOLUTE

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	140.	200.	330.	560.	1030.	2320.	4810.	9130.	25730.	32030.	0.
0.	190.	270.	440.	810.	1780.	5040.	10510.	18220.	28470.	32370.	0.
0.	300.	420.	790.	1870.	4430.	11750.	19720.	25750.	30840.	33140.	0.
0.	470.	670.	1350.	3670.	9510.	19190.	25960.	29750.	32630.	33880.	0.
0.	890.	1290.	2940.	9200.	15540.	24040.	29330.	32050.	33670.	34350.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

```
INITIAL DENSITIES (LB/FT**3)

 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
 0.00 62.44 62.44 62.45 62.46 62.48 62.54 62.66 62.86 63.65 63.95  0.00
 0.00 62.44 62.44 62.45 62.47 62.51 62.67 62.93 63.29 63.78 63.97  0.00
 0.00 62.44 62.45 62.47 62.52 62.64 62.99 63.37 63.65 63.89 64.00  0.00
 0.00 62.45 62.46 62.49 62.60 62.88 63.34 63.66 63.84 63.98 64.04  0.00
 0.00 62.47 62.49 62.57 62.87 63.17 63.57 63.82 63.95 64.03 64.06  0.00
 0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00

INITIAL VISCOSITIES (LB*SEC/FT**2)

  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01
  0.00E-01  0.00E-01
  0.00E-01  2.09E-05  2.09E-05  2.09E-05  2.09E-05  2.10E-05  2.11E-05  2.12E-05  2.18E-05
  2.21E-05  0.00E-01
  0.00E-01  2.09E-05  2.09E-05  2.09E-05  2.09E-05  2.10E-05  2.11E-05  2.13E-05  2.15E-05  2.20E-05
  2.22E-05  0.00E-01
  0.00E-01  2.09E-05  2.09E-05  2.09E-05  2.10E-05  2.10E-05  2.13E-05  2.16E-05  2.18E-05  2.21E-05
  2.22E-05  0.00E-01
  0.00E-01  2.09E-05  2.09E-05  2.09E-05  2.10E-05  2.12E-05  2.16E-05  2.19E-05  2.20E-05  2.22E-05
  2.22E-05  0.00E-01
  0.00E-01  2.09E-05  2.09E-05  2.10E-05  2.12E-05  2.14E-05  2.18E-05  2.20E-05  2.21E-05  2.22E-05
  2.23E-05  0.00E-01
  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01  0.00E-01
  0.00E-01  0.00E-01


CONCENTRATION

NUMBER OF TIME STEPS =      0
       TIME(SECONDS) =  0.00000
  CHEM.TIME(SECONDS) =  0.00000E-01
  CHEM.TIME(DAYS)    =  0.00000E+00
       TIME(YEARS)   =  0.00000E+00
  CHEM.TIME(YEARS)   =  0.00000E-01
 NO. MOVES COMPLETED =      0

               TRACE SOLUTE

    0    0    0    0    0    0    0    0    0    0    0    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0    0    0    0    0    0    0    0    0    0    0    0

               DENSITY-CONTROLLING SOLUTE

    0    0    0    0    0    0    0    0    0    0    0    0

    0  140  200  330  560 1030 2320 4810 91302573032030    0

    0  190  270  440  810 1780 5040105101822028470323 70    0

    0  300  420  790 1870 4430117501972025750308403314 0    0

    0  470  670 1350 3670 9510191902596029750326303388 0    0

    0  890 1290 2940 9200155402404029330320503367034350    0

    0    0    0    0    0    0    0    0    0    0    0    0
BETA= 1.00
 10 ITERATIONS PARAMETERS:
   0.213163E-13   0.680943E+00   0.898203E+00   0.967521E+00   0.989637E+00   0.213163E-13
   0.680943E+00   0.898203E+00   0.967521E+00   0.989637E+00


  N =    1
NUMBER OF ITERATIONS=  22
```

```
PRESSURE DISTRIBUTION - ROW
NUMBER OF TIME STEPS =      1
      TIME(SECONDS) =  0.31558E+09
      TIME(DAYS)    =  3.65250E+03
      TIME(YEARS)   =  1.00000E+01

     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
     0.0000      0.0000
     0.0000    649.9996    599.9997    499.9999    400.0000    300.0001    200.0001    100.0002      0.0006      0.0001
     0.0000      0.0000
     0.0000   6820.6004   6787.5762   6726.6893   6655.0527   6579.3778   6503.9940   6438.2527   6394.2279   6397.1654
  6410.0000      0.0000
     0.0000  13024.5980  13003.5358  12965.1986  12917.2128  12866.4306  12820.5938  12790.1387  12781.3106  12796.6829
 12819.9999      0.0000
     0.0000  19250.3172  19237.7063  19215.4853  19188.8894  19166.7538  19155.2752  19157.1112  19171.7907  19198.2502
 19229.9999      0.0000
     0.0000  25490.0426  25483.5405  25475.2166  25473.4440  25482.7521  25505.8228  25534.1522  25565.5755  25601.3318
 25639.9999      0.0000
     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
     0.0000      0.0000


   PRESSURE MAP

        0     0     0     0     0     0     0     0     0     0     0     0
        0   650   600   500   400   300   200   100     0     0     0     0
        0  6821  6788  6727  6655  6579  6504  6438  6394  6397  6410     0
        0 13025 13004 12965 12917 12866 12821 12790 12781 12797 12820     0
        0 19250 19238 19215 19189 19167 19155 19157 19172 19198 19230     0
        0 25490 25484 25475 25473 25483 25506 25534 25566 25601 25640     0
        0     0     0     0     0     0     0     0     0     0     0     0

    CUMULATIVE MASS BALANCE -- (IN FT**3)

     RECHARGE                      =  0.00000E-01
     DISCHARGE                     =  0.00000E-01
     CUMULATIVE  NET  RECHARGE     =  0.00000E-01
     WATER RELEASE FROM STORAGE    =  0.00000E-01
     LEAKAGE INTO AQUIFER          =  4.59854E+02
     LEAKAGE OUT OF AQUIFER        = -4.59854E+02
     CUMULATIVE  NET  LEAKAGE      =  3.03705E-04

         MASS BALANCE RESIDUAL     =  0.30371E-03
         ERROR  (AS PERCENT)       =  0.66044E-04

    RATE MASS BALANCE -- (IN C.F.S.)

     LEAKAGE INTO AQUIFER          =  1.45719E+00
     LEAKAGE OUT OF AQUIFER        = -1.45719E+00
     NET LEAKAGE     (QNET)        =  9.62384E-07
     RECHARGE                      =  0.00000E-01
     DISCHARGE                     =  0.00000E-01
     NET WITHDRAWAL   (TPUM)       =  0.00000E-01
```

```
          STABILITY CRITERIA --- M.O.C.


 VMAX =  3.20E-06      VMAZ =  1.96E-06
 VMXBD=  3.20E-06      VMZBD=  2.70E-06
 TMV (MAX. INJ.) =  0.17021E+08
 TIMV (CELDIS)   =  0.78099E+07

 TIMV =  7.81E+06      NTIMV =    40      NMOV =    41

  TIM (N)  =  0.31558E+09
  TIMEVELO =  0.76970E+07
  TIMEDISP =  0.77580E+07

 TIMV =  7.70E+06      NTIMD =    40      NMOV =    41

          THE LIMITING STABILITY CRITERION IS CELDIS

          NO. OF PARTICLE MOVES REQUIRED TO COMPLETE THIS TIME STEP  =   41


  NP       =         1051          IMOV     =            1
  TIM(N)   =  0.31558E+09          TIMV     =  0.76970E+07          SUMTCH =  0.76970E+07

RECALCULATE PRESSURES DUE TO CONCENTRATION CHANGE


  N =    1
NUMBER OF ITERATIONS=  13




          STABILITY CRITERIA --- M.O.C.


 VMAX =  3.20E-06      VMAZ =  2.02E-06
 VMXBD=  3.20E-06      VMZBD=  2.73E-06
 TMV (MAX. INJ.) =  0.16990E+08
 TIMV (CELDIS)   =  0.78099E+07

 TIMV =  7.81E+06      NTIMV =    40      NMOV =    41

  TIM (N)  =  0.31558E+09
  TIMEVELO =  0.76970E+07
  TIMEDISP =  0.77573E+07

 TIMV =  7.70E+06      NTIMD =    40      NMOV =    41

          THE LIMITING STABILITY CRITERION IS CELDIS
```

```
CONCENTRATION

NUMBER OF TIME STEPS =      1
       DELTA T       =  0.31558E+09
       TIME(SECONDS) =  0.31558E+09
  CHEM.TIME(SECONDS) =  7.69698E+06
  CHEM.TIME(DAYS)    =  0.89085E+02
       TIME(YEARS)   =  0.10000E+02
  CHEM.TIME(YEARS)   =  2.43902E-01
 NO. MOVES COMPLETED =      1

                TRACE SOLUTE

    0    0    0    0    0    0    0    0    0    0    0    0

    0  311  270   10   10   10   10   10   10   10   10    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0   10   10   10   10   10   10   10   10   10   10    0

    0    0    0    0    0    0    0    0    0    0    0    0

             DENSITY-CONTROLLING SOLUTE

    0    0    0    0    0    0    0    0    0    0    0    0

    0  145  207  336  608 1257 2962 6604117082495831894    0

    0  195  280  467  945 2251 5112 9606161722755432287    0

    0  306  445  874 2017 4812106231833025070306673312O    0

    0  477  702 1489 3924 9247185262585029740325133386 9    0

    0  888 1298 2916 9094156482378429024318383351634335    0

    0    0    0    0    0    0    0    0    0    0    0    0

CHEMICAL MASS BALANCE
                TRACE SOLUTE

       MASS IN BOUNDARIES      =  1.13861E+08
       MASS OUT BOUNDARIES     = -1.78475E+06
       MASS PUMPED IN          =  0.00000E-01
       MASS PUMPED OUT         =  0.00000E-01
       INFLOW MINUS OUTFLOW    =  1.12076E+08
       INITIAL MASS STORED     =  1.00000E+08
       PRESENT MASS STORED     =  2.12079E+08
       CHANGE MASS STORED      =  1.12079E+08
     COMPARE RESIDUAL WITH NET FLUX AND MASS ACCUMULATION:
       MASS BALANCE RESIDUAL   = -2.70385E+03
       ERROR  (AS PERCENT)     = -2.37469E-03
     COMPARE INITIAL MASS STORED WITH CHANGE IN MASS STORED:
       ERROR  (AS PERCENT)     = -2.23896E-02

CHEMICAL MASS BALANCE

                DENSITY-CONTROLLING SOLUTE

       MASS IN BOUNDARIES      =  1.97450E+09
       MASS OUT BOUNDARIES     = -1.70081E+09
       MASS PUMPED IN          =  0.00000E-01
       MASS PUMPED OUT         =  0.00000E-01
       INFLOW MINUS OUTFLOW    =  2.73695E+08
       INITIAL MASS STORED     =  1.28754E+11
       PRESENT MASS STORED     =  1.28098E+11
       CHANGE MASS STORED      = -6.56057E+08
     COMPARE RESIDUAL WITH NET FLUX AND MASS ACCUMULATION:
       MASS BALANCE RESIDUAL   =  9.29752E+08
       ERROR  (AS PERCENT)     =  4.70879E+01
     COMPARE INITIAL MASS STORED WITH CHANGE IN MASS STORED:
       ERROR  (AS PERCENT)     =  7.23653E-01
```

```
CONCENTRATION

NUMBER OF TIME STEPS =      1
       DELTA T       =  0.31558E+09
       TIME(SECONDS) =  0.31558E+09
  CHEM.TIME(SECONDS) =  3.15576E+08
  CHEM.TIME(DAYS)    =  0.36525E+04
       TIME(YEARS)   =  0.10000E+02
  CHEM.TIME(YEARS)   =  1.00000E+01
 NO. MOVES COMPLETED =    41

                TRACE SOLUTE

    0    0    0    0    0    0    0    0    0    0    0    0

    0  951  902  777  711  618  509  407  308  143   50    0

    0  904  861  769  671  566  457  338  228  101   41    0

    0  807  756  671  556  442  356  231  114   48   24    0

    0  604  536  476  372  296  182   96   41   22   15    0

    0  212  228  216  154   90   53   35   22   15   12    0

    0    0    0    0    0    0    0    0    0    0    0    0

             DENSITY-CONTROLLING SOLUTE

    0    0    0    0    0    0    0    0    0    0    0    0

    0  216  376  774 1617 3083 5536 9158131072183428824    0

    0  311  480  945 1906 3686 6723112081699925178302225    0

    0  449  669 1276 2671 5156 8905154222376029636324 17    0

    0  603  929 1811 4126 8184155862333829595323533 3650    0

    0  806 1169 2493 8814178322437728546314493320834120    0

    0    0    0    0    0    0    0    0    0    0    0    0

CHEMICAL MASS BALANCE
                TRACE SOLUTE

       MASS IN BOUNDARIES      =  4.63830E+09
       MASS OUT BOUNDARIES     = -1.27448E+09
       MASS PUMPED IN          =  0.00000E-01
       MASS PUMPED OUT         =  0.00000E-01
       INFLOW MINUS OUTFLOW    =  3.36383E+09
       INITIAL MASS STORED     =  1.00000E+08
       PRESENT MASS STORED     =  3.59895E+09
       CHANGE MASS STORED      =  3.49895E+09
     COMPARE RESIDUAL WITH NET FLUX AND MASS ACCUMULATION:
       MASS BALANCE RESIDUAL   = -1.35126E+08
       ERROR  (AS PERCENT)     = -2.91327E+00
     COMPARE INITIAL MASS STORED WITH CHANGE IN MASS STORED:
       ERROR  (AS PERCENT)     = -4.14012E+00

CHEMICAL MASS BALANCE

                DENSITY-CONTROLLING SOLUTE

       MASS IN BOUNDARIES      =  9.17920E+10
       MASS OUT BOUNDARIES     = -9.34962E+10
       MASS PUMPED IN          =  0.00000E-01
       MASS PUMPED OUT         =  0.00000E-01
       INFLOW MINUS OUTFLOW    = -1.70416E+09
       INITIAL MASS STORED     =  1.28754E+11
       PRESENT MASS STORED     =  1.27107E+11
       CHANGE MASS STORED      = -1.64682E+09
     COMPARE RESIDUAL WITH NET FLUX AND MASS ACCUMULATION:
       MASS BALANCE RESIDUAL   = -5.73390E+07
       ERROR  (AS PERCENT)     = -6.24662E-02
     COMPARE INITIAL MASS STORED WITH CHANGE IN MASS STORED:
       ERROR  (AS PERCENT)     = -4.39520E-02
```

CROSS-SECTIONAL PROBLEM WITH VARIABLE DENSITY

TIME VERSUS HEAD AND CONCENTRATION AT SELECTED OBSERVATION POINTS

PUMPING PERIOD NO. 1

STEADY-STATE SOLUTION

OBS.WELL NO.	X	Z	N	PRESSURE (LB/FT**2)	CONC.(MG/L)	TDS (MG/L)	TIME (YEARS)
1	7	4					
			0	0.0	10.0	11750.0	0.000
			1	12821.0	10.0	10623.1	0.244
			2	12825.2	10.0	9589.7	0.488
			3	12825.7	10.0	10883.2	0.732
			4	12826.3	10.0	9930.0	0.976
			5	12827.8	10.3	9590.4	1.220
			6	12827.8	11.4	10155.3	1.463
			7	12827.9	13.6	9756.9	1.707
			8	12827.9	17.4	9240.1	1.951
			9	12827.9	21.8	10335.0	2.195
			10	12827.9	28.5	10244.6	2.439
			11	12828.1	37.0	9789.1	2.683
			12	12827.7	46.4	9839.2	2.927
			13	12829.3	57.2	9446.7	3.171
			14	12829.3	66.2	10047.3	3.415
			15	12827.4	74.7	9241.7	3.659
			16	12827.4	80.5	9904.2	3.902
			17	12827.2	97.5	9458.6	4.146
			18	12828.5	108.5	9306.3	4.390
			19	12829.0	115.5	9185.0	4.634
			20	12829.0	133.6	9080.0	4.878
			21	12829.5	139.4	9111.4	5.122
			22	12829.5	155.9	8903.1	5.366
			23	12827.4	147.9	9098.9	5.610
			24	12827.4	152.1	9566.0	5.854
			25	12827.4	180.7	9222.6	6.098
			26	12827.2	200.0	9218.4	6.341
			27	12827.2	201.1	9149.8	6.585
			28	12827.2	213.8	8792.0	6.829
			29	12827.9	231.9	8536.0	7.073
			30	12827.9	248.0	8616.8	7.317
			31	12828.2	238.9	9132.1	7.561
			32	12828.2	256.3	8849.4	7.805
			33	12828.2	275.1	8618.6	8.049
			34	12826.8	280.2	8831.9	8.293
			35	12826.8	278.2	9347.3	8.537
			36	12826.8	274.1	9406.1	8.780
			37	12828.0	297.8	9426.6	9.024
			38	12828.0	310.2	9497.1	9.268
			39	12828.0	309.0	9902.6	9.512
			40	12828.0	339.2	9392.2	9.756
			41	12829.1	356.0	8905.4	10.000

```
 PRESSURE DISTRIBUTION - ROW
 NUMBER OF TIME STEPS =      1
        TIME(SECONDS) =  0.31558E+09
        TIME(DAYS)    =  3.65250E+03
        TIME(YEARS)   =  1.00000E+01


    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
    0.0000      0.0000
    0.0000    649.9996    599.9997    499.9999    400.0000    300.0001    200.0001    100.0002      0.0006      0.0001
    0.0001      0.0000
    0.0000   6821.9500   6789.1432   6728.8278   6658.4667   6585.2778   6513.8730   6448.9856   6400.5963   6396.5393
 6409.9999      0.0000
    0.0000  13027.2510  13006.4717  12968.8480  12922.1782  12873.5568  12829.0524  12796.2058  12782.2901  12794.2695
12819.9999      0.0000
    0.0000  19254.0165  19241.6942  19219.9270  19193.0369  19168.3022  19153.5298  19153.2745  19168.1763  19195.4638
19229.9999      0.0000
    0.0000  25493.9469  25487.5349  25478.9805  25476.2633  25483.1227  25500.2442  25526.4975  25560.1024  25597.9893
25639.9999      0.0000
    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
    0.0000      0.0000


 PRESSURE MAP

      0     0     0     0     0     0     0     0     0     0     0     0
      0   650   600   500   400   300   200   100     0     0     0     0
      0  6822  6789  6729  6658  6585  6514  6449  6401  6397  6410     0
      0 13027 13006 12969 12922 12874 12829 12796 12782 12794 12820     0
      0 19254 19242 19220 19193 19168 19154 19153 19168 19195 19230     0
      0 25494 25488 25479 25476 25483 25500 25526 25560 25598 25640     0
      0     0     0     0     0     0     0     0     0     0     0     0

 CUMULATIVE MASS BALANCE -- (IN FT**3)

  RECHARGE                    =  0.00000E-01
  DISCHARGE                   =  0.00000E-01
  CUMULATIVE  NET  RECHARGE   =  0.00000E-01
  WATER RELEASE FROM STORAGE  =  0.00000E-01
  LEAKAGE INTO AQUIFER        =  1.09362E+04
  LEAKAGE OUT OF AQUIFER      = -1.09362E+04
  CUMULATIVE  NET  LEAKAGE    =  8.09610E-03

      MASS BALANCE RESIDUAL   =  0.80961E-02
      ERROR  (AS PERCENT)     =  0.74031E-04

 RATE MASS BALANCE -- (IN C.F.S.)

  LEAKAGE INTO AQUIFER        =  1.53639E+00
  LEAKAGE OUT OF AQUIFER      = -1.53639E+00
  NET LEAKAGE    (QNET)       =  5.70576E-07
  RECHARGE                    =  0.00000E-01
  DISCHARGE                   =  0.00000E-01
  NET WITHDRAWAL   (TPUM)     =  0.00000E-01
```

Appendix IV:

Program Listing

```
C     ******************************************************************    A  10
C     *                                                                *    A  20
C     *      SOLUTE TRANSPORT AND DISPERSION IN A POROUS MEDIUM        *    A  30
C     *       NUMERICAL SOLUTION --- METHOD OF CHARACTERISTICS          *    A  40
C     *       PROGRAMMED BY L. F. KONIKOW AND J. D. BREDEHOEFT          *    A  50
C     *        MODIFIED BY W. E. SANFORD FOR CROSS-SECTIONAL            *    A  60
C     *           2-DIMENSIONAL FLOW WITH VARIABLE DENSITY              *    A  70
C     *                 AND TWO DISSOLVED CONSTITUENTS                 *    A  80
C     *                   AUGUST 1984 - NOVEMBER 1985                  *    A  90
C     *                                                                *    A 100
C     *                                                                *    A 110
C     ******************************************************************    A 120
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                    A 130
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO     A 140
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTMV,NPNTVL,NPNTD,N     A 150
     2PNCHV,NPDELC,ICHK,NCONST                                               A 160
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500),     A 170
     1IXOBS(5),IZOBS(5)                                                      A 180
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24     A 190
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR     A 200
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),AOPT(20),TITLE(10),ANFCTR,X     A 210
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL        A 220
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24,     A 230
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5,     A 240
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C     A 250
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI     A 260
     4S,DLTRAT,CSTORM,CSTORT,DMOLEC                                          A 270
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VZBDY(24,20),SUMTDS(24,20),     A 280
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)           A 290
C     ******************************************************************    A 300
C      ---LOAD DATA---                                                       A 310
      INT=0                                                                  A 320
      TMSUM=0.0                                                              A 330
      CALL PARLOD                                                            A 340
      CALL GENPT                                                             A 350
C     ******************************************************************    A 360
C     ---START COMPUTATIONS---                                               A 370
C        ---COMPUTE ONE PUMPING PERIOD---                                    A 380
      DO 160 INT=1,NPMP                                                      A 390
      IF (INT.GT.1) TMSUM=TMSUM+PYR                                          A 400
      IF (INT.GT.1) CALL PARLOD                                              A 410
      IPCK=0                                                                 A 420
C        ---COMPUTE ONE TIME STEP---                                         A 430
      DO 140 N=1,NTIM                                                        A 440
      IPRNT=0                                                                A 450
C        ---LOAD NEW DELTA T---                                              A 460
      TINT=SUMT-TMSUM                                                        A 470
      TDEL=DMIN1(TIM(N),PYR-TINT)                                            A 480
      SUMT=SUMT+TDEL                                                         A 490
      IF (TDEL.EQ.(PYR-TINT)) IPCK=1                                         A 500
      TIM(N)=TDEL                                                            A 510
      REMN=MOD(N,NPNT)                                                       A 520
C     ******************************************************************    A 530
```

```
      IF (S.EQ.0.0.AND.ICHK.EQ.0.AND.(N.GT.1.OR.INT.GT.1)) GO TO 110      A 540
      CALL ITERAT                                                         A 550
      IF (REMN.EQ.0.0.OR.N.EQ.NTIM.OR.IPCK.EQ.1) CALL OUTPT               A 560
      CALL VELO                                                           A 570
  110 CALL MVPT                                                           A 580
C     ******************************************************************* A 590
C     ---STORE OBS. WELL DATA FOR TRANSIENT FLOW PROBLEMS---              A 600
      IF (S.EQ.0.0) GO TO 130                                             A 610
      IF (NUMOBS.LE.0) GO TO 130                                          A 620
      J=MOD(N,50)                                                         A 630
      IF (J.EQ.0) J=50                                                    A 640
      TMOBS(J)=SUMT                                                       A 650
      DO 120 I=1,NUMOBS                                                   A 660
      TMWL(I,J)=PK(IXOBS(I),IZOBS(I))                                     A 670
      TMCN(I,J)=CONC(IXOBS(I),IZOBS(I))                                   A 680
  120 CONTINUE                                                            A 690
C     ******************************************************************* A 700
C     ---OUTPUT ROUTINES---                                               A 710
  130 IF (REMN.EQ.0.0.OR.N.EQ.NTIM.OR.MOD(N,50).EQ.0.OR.IPCK.EQ.1) CALL   A 720
     1CHMOT                                                               A 730
      IF (SUMT.GE.(PYR+TMSUM)) GO TO 150                                  A 740
  140 CONTINUE                                                            A 750
C     ******************************************************************* A 760
C     ---SUMMARY OUTPUT---                                                A 770
  150 CONTINUE                                                            A 780
      IPRNT=1                                                             A 790
      CALL CHMOT                                                          A 800
  160 CONTINUE                                                            A 810
      CALL OUTPT                                                          A 820
C     ******************************************************************* A 830
      ENDFILE(6)                                                          A 840
      IF (NPNCHV.EQ.0) GO TO 170                                          A 850
      ENDFILE(7)                                                          A 860
  170 CONTINUE                                                            A 870
      STOP                                                                A 880
C     ******************************************************************* A 890
      END                                                                 A 900-
      SUBROUTINE PARLOD                                                   B  10
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                 B  20
      INTEGER OVERRD                                                      B  30
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO  B  40
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTMV,NPNTVL,NPNTD,N  B  50
     2PNCHV,NPDELC,ICHK,NCONST                                            B  60
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500),  B  70
     1IXOBS(5),IZOBS(5)                                                   B  80
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24  B  90
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR  B 100
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),ADPT(20),TITLE(10),ANFCTR,X  B 110
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL      B 120
      COMMON /DENVIS/ DEN1,DEN2,VIS1,VIS2                                 B 130
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24,  B 140
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5,  B 150
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C  B 160
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI  B 170
     45,DLTRAT,CSTORM,CSTORT,DMOLEC                                       B 180
      COMMON /BALM/ TOTLQ,TOTLQI,TPIN,TPOUT                               B 190
      COMMON /XINV/ DXINV,DZINV,ARINV,PORINV                              B 200
```

```
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VZBDY(24,20),SUMTDS(24,20),    B 210
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)          B 220
      COMMON /CNCHNG/ CNCHCK(24,20),CTOL                                    B 230
C     ****************************************************************    B 240
      IF (INT.GT.1) GO TO 10                                                B 250
      WRITE (6,760)                                                         B 260
      READ (5,730) TITLE                                                    B 270
      WRITE (6,740) TITLE                                                   B 280
C     ****************************************************************    B 290
C     ---INITIALIZE TEST AND CONTROL VARIABLES---                           B 300
      STORMI=0.0                                                            B 310
      STORTI=0.0                                                            B 320
      TEST=0.0                                                              B 330
      TOTLQ=0.0                                                             B 340
      TOTLQI=0.0                                                            B 350
      TPIN=0.0                                                              B 360
      TPOUT=0.0                                                             B 370
      SUMT=0.0                                                              B 380
      SUMTCH=0.0                                                            B 390
      INT=0                                                                 B 400
      IPRNT=0                                                               B 410
      NCA=0                                                                 B 420
      N=0                                                                   B 430
      IMOV=0                                                                B 440
      NMOV=0                                                                B 450
      ICHK=0                                                                B 460
C     ****************************************************************    B 470
C     ---LOAD CONTROL PARAMETERS---                                         B 480
      READ (5,750) NTIM,NPMP,NX,NZ,NPMAX,NPNT,NUMOBS,ITMAX,NREC,NPTPND,N    B 490
     1CODES,NZCRIT,NCONST,NPNTMV,NPNTVL,NPNTD,NPDELC,NPNCHV                 B 500
      READ (5,810) PINT,TOL,POROS,BETA,S,TIMX,TINIT                         B 510
      READ (5,820) XDEL,ZDEL,DLTRAT,CELDIS,ANFCTR,WIDTH,CTOL,DMOLEC         B 520
      NNX=NX-1                                                              B 530
      NNZ=NZ-1                                                              B 540
      NP=NPMAX                                                              B 550
      NITP=10                                                               B 560
      A1=1.0D0                                                              B 570
      A2=2.0D0                                                              B 580
      A3=86400.0D0                                                          B 590
      A4=365.25D0                                                           B 600
      A5=3.1415927D0                                                        B 610
      DXINV=A1/XDEL                                                         B 620
      DZINV=A1/ZDEL                                                         B 630
      ARINV=DXINV*DZINV                                                     B 640
      PORINV=A1/POROS                                                       B 650
C     ---PRINT CONTROL PARAMETERS---                                        B 660
      WRITE (6,770)                                                         B 670
      WRITE (6,780) NX,NZ,XDEL,ZDEL,WIDTH                                   B 680
      WRITE (6,790) NTIM,NPMP,PINT,TIMX,TINIT                               B 690
      WRITE (6,800) S,POROS,BETA,DLTRAT,ANFCTR,DMOLEC,NCONST                B 700
      WRITE (6,880) TOL,ITMAX,CELDIS,NPMAX,NPTPND,CTOL                      B 710
      IF (NPTPND.NE.4.AND.NPTPND.NE.5.AND.NPTPND.NE.8.AND.NPTPND.NE.9..A    B 720
     1ND.NPTPND.NE.16) WRITE (6,890)                                        B 730
      WRITE (6,900) NPNT,NPNTMV,NPNTVL,NPNTD,NUMOBS,NREC,NCODES,NPNCHV,N    B 740
     1PDELC                                                                 B 750
      GO TO 20                                                              B 760
C     ****************************************************************    B 770
```

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C     ---READ DATA TO REVISE TIME STEPS AND STRESSES FOR SUBSEQUENT      B 780
C        PUMPING PERIODS---                                              B 790
   10 READ (5,980) ICHK                                                  B 800
      IF (ICHK.LE.0) WRITE (6,1020) INT                                  B 810
      IF (ICHK.LE.0) GO TO 20                                            B 820
      READ (5,990) NTIM,NPNT,ITMAX,NREC,NPNTMV,NPNTVL,NPNTD,NPDELC,NPNCH B 830
     1V,PINT,TIMX,TINIT                                                  B 840
      WRITE (6,1000) INT                                                 B 850
      WRITE (6,1010) NTIM,NPNT,NITP,ITMAX,NREC,NPNTMV,NPNTVL,NPNTD,NPDEL B 860
     1C,NPNCHV,PINT,TIMX,TINIT                                           B 870
C     ******************************************************************B 880
C     ---LIST TIME INCREMENTS---                                         B 890
   20 DO 30 J=1,100                                                      B 900
      TIM(J)=0.0                                                         B 910
   30 CONTINUE                                                           B 920
      PYR=PINT*A3*A4                                                     B 930
      TIM(1)=TINIT                                                       B 940
      IF (NPNTMV.EQ.0) NPNTMV=999                                        B 950
      IF (S.EQ.0.0) GO TO 50                                             B 960
      DO 40 K=2,NTIM                                                     B 970
   40 TIM(K)=TIMX*TIM(K-1)                                               B 980
      WRITE (6,520)                                                      B 990
      WRITE (6,550) TIM                                                  B1000
      IF (TINIT.GT.PYR) WRITE (6,530)                                    B1010
      GO TO 70                                                           B1020
   50 ANTIM=NTIM                                                         B1030
      DO 60 K=1,NTIM                                                     B1040
   60 TIM(K)=PYR/ANTIM                                                   B1050
      WRITE (6,540) TIM(1)                                               B1060
C     ******************************************************************B1070
C     ---INITIALIZE MATRICES---                                          B1080
   70 IF (INT.GT.1) GO TO 110                                            B1090
      DO 80 IZ=1,NZ                                                      B1100
      DO 80 IX=1,NX                                                      B1110
      VPRM(IX,IZ)=0.0                                                    B1120
      ELEV(IX,IZ)=0.0                                                    B1130
      PERM(IX,IZ)=0.0                                                    B1140
      NODEID(IX,IZ)=0                                                    B1150
      PMRX(IX,IZ,1)=0.0                                                  B1160
      PMRX(IX,IZ,2)=0.0                                                  B1170
      PMRX(IX,IZ,3)=0.0                                                  B1180
      PMRX(IX,IZ,4)=0.0                                                  B1190
      PI(IX,IZ)=0.0                                                      B1200
      PR(IX,IZ)=0.0                                                      B1210
      PC(IX,IZ)=0.0                                                      B1220
      PK(IX,IZ)=0.0                                                      B1230
      DENS(IX,IZ)=0.0                                                    B1240
      VISC(IX,IZ)=0.0                                                    B1250
      GTERM(IX,IZ)=0.0                                                   B1260
      VX(IX,IZ)=0.0                                                      B1270
      VZ(IX,IZ)=0.0                                                      B1280
      VXBDY(IX,IZ)=0.0                                                   B1290
      VZBDY(IX,IZ)=0.0                                                   B1300
      CONC(IX,IZ)=0.0                                                    B1310
      CONINT(IX,IZ)=0.0                                                  B1320
      SUMC(IX,IZ)=0.0                                                    B1330
      TDS(IX,IZ)=0.0                                                     B1340
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      TDSINT(IX,IZ)=0.0                                                 B1350
      SUMTDS(IX,IZ)=0.0                                                 B1360
      CNREC(IX,IZ)=0.0                                                  B1370
      REC(IX,IZ)=0.0                                                    B1380
      SUMWT(IX,IZ)=0.0                                                  B1390
      PTQ(IX,IZ)=0.0                                                    B1400
   80 CONTINUE                                                          B1410
C     ******************************************************************B1420
C     ---READ OBSERVATION WELL LOCATIONS---                             B1430
      IF (NUMOBS.LE.0) GO TO 110                                        B1440
      WRITE (6,910)                                                     B1450
      DO 90 J=1,NUMOBS                                                  B1460
      READ (5,710) IX,IZ                                                B1470
      WRITE (6,830) J,IX,IZ                                             B1480
      IXOBS(J)=IX                                                       B1490
   90 IZOBS(J)=IZ                                                       B1500
      DO 100 I=1,NUMOBS                                                 B1510
      DO 100 J=1,50                                                     B1520
      TMWL(I,J)=0.0                                                     B1530
      TMCN(I,J)=0.0                                                     B1540
  100 TMTDS(I,J)=0.0                                                    B1550
C     ******************************************************************B1560
C             --- READ SPECIFIED RECHARGE AND/OR DISCHARGE ---          B1570
C                   (X-Z COORDINATES AND RATE IN CFS)                   B1580
C       ---SIGNS:  RECHARGE = NEGATIVE,  DISCHARGE = POSITIVE---        B1590
C       ---IF RECHARGE, ALSO READ CONCENTRATION OF RECHARGE WATER---    B1600
  110 IF (NREC.LE.0) GO TO 140                                          B1610
      IF (INT.GT.1.AND.ICHK.LE.0) RETURN                                B1620
      WRITE (6,920)                                                     B1630
      DO 130 I=1,NREC                                                   B1640
      READ (5,720) IX,IZ,FCTR,CNREC1,CNREC2                             B1650
      IF (FCTR.GT.0.0) GO TO 120                                        B1660
      CNREC(IX,IZ)=CNREC1                                               B1670
      TDSREC(IX,IZ)=CNREC2                                              B1680
  120 REC(IX,IZ)=FCTR                                                   B1690
  130 WRITE (6,840) IX,IZ,REC(IX,IZ),CNREC(IX,IZ),TDSREC(IX,IZ)         B1700
C     ******************************************************************B1710
  140 IF (INT.GT.1) RETURN                                              B1720
      AREA=XDEL*ZDEL                                                    B1730
      VOL=AREA*WIDTH                                                    B1740
      WRITE (6,700) AREA                                                B1750
      WRITE (6,620)                                                     B1760
      WRITE (6,630) XDEL                                                B1770
      WRITE (6,630) ZDEL                                                B1780
C     ******************************************************************B1790
C                   ---READ PERMEABILITY IN FT**2---                    B1800
      WRITE (6,560)                                                     B1810
      READ (5,570) INPUT,FCTR                                           B1820
      DO 180 IZ=1,NZ                                                    B1830
      IF (INPUT.EQ.1) READ (5,580) (PERM(IX,IZ),IX=1,NX)                B1840
      DO 170 IX=1,NX                                                    B1850
      IF (INPUT.NE.1) GO TO 150                                         B1860
      PERM(IX,IZ)=PERM(IX,IZ)*FCTR                                      B1870
      GO TO 160                                                         B1880
  150 PERM(IX,IZ)=FCTR                                                  B1890
  160 IF (PERM(IX,IZ).NE.0.0) NCA=NCA+1                                 B1900
  170 CONTINUE                                                          B1910
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  180 WRITE (6,850) (PERM(IX,IZ),IX=1,NX)                                  B1920
C     ***************************************************************     B1930
C     --- READ VERTICAL PERMEABILITY FACTOR ---                           B1940
      READ (5,570) INPUT,FCTR                                              B1950
      IF (INPUT.EQ.0) GO TO 220                                            B1960
      DO 200 IZ=1,NZ                                                       B1970
      READ (5,580) (VPRM(IX,IZ),IX=1,NX)                                   B1980
      DO 190 IX=1,NX                                                       B1990
      VPRM(IX,IZ)=VPRM(IX,IZ)*FCTR                                         B2000
  190 CONTINUE                                                             B2010
  200 CONTINUE                                                             B2020
      DO 210 IZ=1,NZ                                                       B2030
      READ (5,580) (ELEV(IX,IZ),IX=1,NX)                                   B2040
  210 CONTINUE                                                             B2050
C     ***************************************************************     B2060
  220 AAQ=NCA*AREA                                                         B2070
      WRITE (6,650) NCA,AAQ,NZCRIT                                         B2080
C     ***************************************************************     B2090
C     ---READ NODE IDENTIFICATION CARDS---                                B2100
C        ---SET VERT. PERM.,  SOURCE CONC.,  AND DIFFUSE RECHARGE---      B2110
C           ---SPECIFY CODES TO FIT YOUR NEEDS---                         B2120
      WRITE (6,590)                                                        B2130
      READ (5,570) INPUT,FCTR                                              B2140
      DO 240 IZ=1,NZ                                                       B2150
      IF (INPUT.EQ.1) READ (5,660) (NODEID(IX,IZ),IX=1,NX)                 B2160
      DO 230 IX=1,NX                                                       B2170
  230 IF (INPUT.NE.1.AND.PERM(IX,IZ).NE.0.0) NODEID(IX,IZ)=FCTR            B2180
  240 WRITE (6,600) (NODEID(IX,IZ),IX=1,NX)                                B2190
      WRITE (6,930) NCODES                                                 B2200
      IF (NCODES.LE.0) GO TO 280                                           B2210
      WRITE (6,940)                                                        B2220
      DO 270 IJ=1,NCODES                                                   B2230
      READ (5,860) ICODE,FCTR1,FCTR2                                       B2240
      DO 260 IX=1,NX                                                       B2250
      DO 260 IZ=1,NZ                                                       B2260
      IF (NODEID(IX,IZ).NE.ICODE) GO TO 260                                B2270
      IF (ELEV(IX,IZ).NE.0.0) GO TO 250                                    B2280
      VPRM(IX,IZ)=10000000000.*PERM(IX,IZ)/((XDEL+ZDEL)*0.5)               B2290
  250 TDSREC(IX,IZ)=FCTR1                                                  B2300
      CNREC(IX,IZ)=FCTR2                                                   B2310
  260 CONTINUE                                                             B2320
  270 WRITE (6,870) ICODE,FCTR1,FCTR2                                      B2330
  280 WRITE (6,610)                                                        B2340
      DO 290 IZ=1,NZ                                                       B2350
  290 WRITE (6,850) (VPRM(IX,IZ),IX=1,NX)                                  B2360
      IWRITE=0                                                             B2370
      DO 300 IZ=1,NZ                                                       B2380
      DO 300 IX=1,NX                                                       B2390
  300 IF (ELEV(IX,IZ).NE.0.0) IWRITE=1                                     B2400
      IF (IWRITE.EQ.1) WRITE (6,640)                                       B2410
      DO 310 IZ=1,NZ                                                       B2420
  310 IF (IWRITE.EQ.1) WRITE (6,850) (ELEV(IX,IZ),IX=1,NX)                 B2430
C     ***************************************************************     B2440
C     ---READ INITIAL PRESSURES---                                        B2450
      WRITE (6,680)                                                        B2460
      READ (5,570) INPUT,FCTR                                              B2470
      DO 340 IZ=1,NZ                                                       B2480
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      IF (INPUT.EQ.1) READ (5,670) (PI(IX,IZ),IX=1,NX)                  B2490
      DO 330 IX=1,NX                                                    B2500
      IF (INPUT.NE.1) GO TO 320                                         B2510
      PI(IX,IZ)=PI(IX,IZ)*FCTR                                          B2520
      GO TO 330                                                         B2530
  320 IF (PERM(IX,IZ).NE.0.0) PI(IX,IZ)=FCTR                            B2540
  330 CONTINUE                                                          B2550
  340 WRITE (6,690) (PI(IX,IZ),IX=1,NX)                                 B2560
C     ********************************************************************B2570
C     ---SET INITIAL PRESSURES---                                       B2580
      DO 350 IX=1,NX                                                    B2590
      DO 350 IZ=1,NZ                                                    B2600
      PC(IX,IZ)=PI(IX,IZ)                                               B2610
      PR(IX,IZ)=PI(IX,IZ)                                               B2620
  350 PX(IX,IZ)=PI(IX,IZ)                                               B2630
C                                                                       B2640
      CALL OUTPT                                                        B2650
C     ********************************************************************B2660
C     ---READ INITIAL CONCENTRATIONS AND COMPUTE INITIAL MASS STORED---  B2670
      IF (NCONST.LT.2) GO TO 400                                        B2680
      WRITE (6,510)                                                     B2690
      READ (5,570) INPUT,FCTR                                           B2700
      DO 390 IZ=1,NZ                                                    B2710
      IF (INPUT.EQ.1) READ (5,670) (CONC(IX,IZ),IX=1,NX)                B2720
      DO 380 IX=1,NX                                                    B2730
      IF (INPUT.NE.1) GO TO 360                                         B2740
      CONC(IX,IZ)=CONC(IX,IZ)*FCTR                                      B2750
      GO TO 370                                                         B2760
  360 IF (PERM(IX,IZ).NE.0.0) CONC(IX,IZ)=FCTR                          B2770
  370 CONINT(IX,IZ)=CONC(IX,IZ)                                         B2780
  380 STORMI=STORMI+CONINT(IX,IZ)*VOL*POROS                             B2790
  390 WRITE (6,690) (CONC(IX,IZ),IX=1,NX)                               B2800
  400 WRITE (6,1070)                                                    B2810
      READ (5,570) INPUT,FCTR                                           B2820
      DO 440 IZ=1,NZ                                                    B2830
      IF (INPUT.EQ.1) READ (5,670) (TDS(IX,IZ),IX=1,NX)                 B2840
      DO 430 IX=1,NX                                                    B2850
      IF (INPUT.NE.1) GO TO 410                                         B2860
      TDS(IX,IZ)=TDS(IX,IZ)*FCTR                                        B2870
      GO TO 420                                                         B2880
  410 IF (PERM(IX,IZ).NE.0.0) TDS(IX,IZ)=FCTR                           B2890
  420 TDSINT(IX,IZ)=TDS(IX,IZ)                                          B2900
      STORTI=STORTI+TDSINT(IX,IZ)*VOL*POROS                             B2910
  430 CNCHCK(IX,IZ)=TDS(IX,IZ)                                          B2920
  440 WRITE (6,690) (TDS(IX,IZ),IX=1,NX)                                B2930
C     ********************************************************************B2940
C       --- CALCULATE INITIAL DENSITIES AND VISCOSITIES ---             B2950
      VIS1=0.0                                                          B2960
      VIS2=0.0                                                          B2970
      DEN1=4.743E-05                                                    B2980
      DEN2=62.43                                                        B2990
      READ (5,980) INPUT                                                B3000
      IF (INPUT.GT.0) READ (5,1060) DEN1,DEN2,VIS1,VIS2                 B3010
      DO 470 IZ=2,NNZ                                                   B3020
      DO 470 IX=2,NNX                                                   B3030
      DENS(IX,IZ)=DEN1*TDS(IX,IZ)+DEN2                                  B3040
      DENSE=DENS(IX,IZ)                                                 B3050
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      IF (REC(IX,IZ).LT.0.0) DENSE=DEN1*TDSREC(IX,IZ)+DEN2                  B3060
      REC(IX,IZ)=(REC(IX,IZ)*DENSE)/VOL                                     B3070
      IF (INPUT.GT.0) GO TO 460                                             B3080
      IF (TDS(IX,IZ).GT.20000.) GO TO 450                                   B3090
      VISC(IX,IZ)=3.45E-11*TDS(IX,IZ)+2.089E-05                             B3100
      GO TO 470                                                             B3110
  450 VISC(IX,IZ)=4.733E-11*TDS(IX,IZ)+2.063E-05                            B3120
      GO TO 470                                                             B3130
  460 VISC(IX,IZ)=VIS1*TDS(IX,I )+VIS2                                      B3140
  470 CONTINUE                                                              B3150
      WRITE (6,1030)                                                        B3160
      DO 480 IZ=1,NZ                                                        B3170
  480 WRITE (6,1040) (DENS(IX,IZ),IX=1,NX)                                  B3180
      WRITE (6,1050)                                                        B3190
      DO 490 IZ=1,NZ                                                        B3200
  490 WRITE (6,850) (VISC(IX,IZ),IX=1,NX)                                   B3210
C     ***************************************************************     B3220
C     ---CHECK DATA SETS FOR INTERNAL CONSISTENCY---                        B3230
      DO 500 IX=1,NX                                                        B3240
      DO 500 IZ=1,NZ                                                        B3250
      IF (PERM(IX,IZ).GT.0.0) GO TO 500                                     B3260
      IF (NODEID(IX,IZ).GT.0.0) WRITE (6,950) IX,IZ                         B3270
      IF (PI(IX,IZ).NE.0.0) WRITE (6,960) IX,IZ                             B3280
      IF (REC(IX,IZ).NE.0.0) WRITE (6,970) IX,IZ                            B3290
                                                                            B3300
  500 CONTINUE                                                              B3310
C     ***************************************************************     B3320
      RETURN                                                                B3330
C     ***************************************************************     B3340
C                                                                           B3350
C                                                                           B3360
C                                                                           B3370
  510 FORMAT (1H1,40HINITIAL CONCENTRATION MAP - TRACE SOLUTE/)             B3380
  520 FORMAT (1H1,27HTIME INTERVALS (IN SECONDS))                           B3390
  530 FORMAT (1H0,5X,65H*** WARNING ***   INITIAL TIME STEP IS LONGER TH    B3400
     1AN PUMPING PERIOD/25X,34H***ADJUST EITHER TINIT OR PINT.***/)         B3410
  540 FORMAT (1H1,15X,17HSTEADY-STATE FLOW//5X,57HTIME INTERVAL (IN SEC)    B3420
     1 FOR SOLUTE-TRANSPORT SIMULATION = ,G12.5)                            B3430
  550 FORMAT (3H   ,10G12.5)                                                B3440
  560 FORMAT (1H1,24HPERMEABILITY MAP (FT**2))                              B3450
  570 FORMAT (I1,G10.0)                                                     B3460
  580 FORMAT (24G3.0)                                                       B3470
  590 FORMAT (1H1,23HNODE IDENTIFICATION MAP//)                             B3480
  600 FORMAT (1H ,24I5)                                                     B3490
  610 FORMAT (1H1,39HVERTICAL PERMEABILITY FACTOR (1/FT*SEC))               B3500
  620 FORMAT (1H0,10X,12HX-Z SPACING:)                                      B3510
  630 FORMAT (1H ,12X,10G12.5)                                              B3520
  640 FORMAT (1H1,27HCONFINING BED THICKNESS MAP//)                         B3530
  650 FORMAT (1H0,////10X,44HNO. OF FINITE-DIFFERENCE CELLS IN AQUIFER =    B3540
     1 ,I4//10X,28HAREA OF AQUIFER IN MODEL  = ,G12.5,10H   SQ. FT.////1    B3550
     20X,47HNZCRIT   (MAX. NO. OF CELLS THAT CAN BE VOID OF/20X,56HPARTI    B3560
     3CLES;  IF EXCEEDED, PARTICLES ARE REGENERATED)   = ,I4/)              B3570
  660 FORMAT (24I1)                                                         B3580
  670 FORMAT (12G6.0)                                                       B3590
  680 FORMAT (1H1,28HINITIAL PRESSURES (LB/FT**2)//)                        B3600
  690 FORMAT (1H ,20F6.0)                                                   B3610
  700 FORMAT (1H0,10X,19HAREA OF ONE CELL = ,G12.4)                         B3620
  710 FORMAT (2I2)
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  720 FORMAT (2I2,3G10.2)                                                    B3630
  730 FORMAT (10A8)                                                          B3640
  740 FORMAT (1H0,10A8)                                                      B3650
  750 FORMAT (20I4)                                                          B3660
  760 FORMAT (1H1,77HU.S.G.S. METHOD-OF-CHARACTERISTICS MODEL FOR SOLUTE     B3670
     1 TRANSPORT IN GROUND WATER)                                            B3680
  770 FORMAT (1H0,21X,21HI N P U T     D A T A)                              B3690
  780 FORMAT (1H0,23X,16HGRID DESCRIPTORS//13X,30HNX    (NUMBER OF COLUM     B3700
     1NS)  =  ,I4/13X,28HNZ    (NUMBER OF ROWS)     =,I6/13X,29HXDEL  (X     B3710
     2-DISTANCE IN FEET) = ,F9.3/13X,29HZDEL  (Z-DISTANCE IN FEET) = ,F9     B3720
     3.3/13X,29HWIDTH (Y-DISTANCE IN FEET) = ,F9.3)                          B3730
  790 FORMAT (1H0,23X,16HTIME  PARAMETERS//13X,40HNTIM   (MAX. NO. OF TI     B3740
     1ME STEPS)       = ,I6/13X,40HNPMP   (NO. OF PUMPING PERIODS)          B3750
     2 = ,I6/13X,39HPINT   (PUMPING PERIOD IN YEARS)      =,F11.3/13X,39     B3760
     3HTIMX   (TIME INCREMENT MULTIPLIER)    =,F10.2/13X,39HTINIT  (INIT     B3770
     4IAL TIME STEP IN SEC.)    =,F8.0)                                      B3780
  800 FORMAT (1H0,14X,34HHYDROLOGIC AND CHEMICAL PARAMETERS//13X,1HS,7X,     B3790
     129H(SPECIFIC STORAGE)          =,5X,F9.6/13X,28HPOROS   (EFFECTIVE     B3800
     2 POROSITY),8X,3H=  ,F8.2/13X,39HBETA    (LONGITUDINAL DISPERSIVITY     B3810
     3) =  ,F7.1/13X,31HDLTRAT  (RATIO OF TRANSVERSE TO/21X,30H LONGITUD     B3820
     4INAL DISPERSIVITY) = ,F9.2/13X,39HANFCTR  (RATIO OF K-ZZ TO K-XX)      B3830
     5    =  ,F12.6/13X,28HDMOLEC  (COEF. OF DIFFUSION),8X,3H=  ,1PE9.2/     B3840
     613X,39HNCONST  (NUMBER OF CONSTITUENTS)    =  ,I2)                     B3850
  810 FORMAT (7G10.0)                                                        B3860
  820 FORMAT (8G10.0)                                                        B3870
  830 FORMAT (1H ,16X,I2,5X,I2,4X,I2)                                        B3880
  840 FORMAT (1H ,7X,2I4,3X,E12.5,2(3X,F8.2))                                B3890
  850 FORMAT (1H ,1P10E10.2)                                                 B3900
  860 FORMAT (I2,2G10.2)                                                     B3910
  870 FORMAT (1H ,7X,I2,2(7X,F9.2))                                          B3920
  880 FORMAT (1H0,21X,20HEXECUTION PARAMETERS//13X,39HTOL    (CONVERGENC     B3930
     1E CRITERIA - SIP)  = ,F9.7/13X,39HITMAX  (MAX.NO.OF ITERATIONS - S     B3940
     2IP)  = ,I4/13X,34HCELDIS (MAX.CELL DISTANCE PER MOVE/24X,28HOF PAR     B3950
     3TICLES - M.O.C.)    = ,F8.3/13X,30HNPMAX  (MAX. NO. OF PARTICLES),     B3960
     47X,2H= ,I4/12X,32H NPTPND (NO. PARTICLES PER NODE),6X,3H=  ,I4/13X     B3970
     5,33HCTOL   (MINIMUM CONC. CHANGE     /21X,31HFOR PRESSURE RECALCUL     B3980
     6ATION)  = ,F5.0)                                                       B3990
  890 FORMAT (1H0,5X,47H*** WARNING *** NPTPND MUST EQUAL 4,5,8,9,OR 16)     B4000
  900 FORMAT (1H0,23X,15HPROGRAM OPTIONS//13X,30HNPNT   (TIME STEP INTER     B4010
     1VAL FOR/21X,18HCOMPLETE PRINTOUT),7X,3H=  ,I4/13X,31HNPNTMV (MOVE      B4020
     2INTERVAL FOR CHEM./21X,28HCONCENTRATION PRINTOUT)  =  ,I4/13X,29HN     B4030
     3PNTVL (PRINT OPTION-VELOCITY/21X,24H0=NO; 1=FIRST TIME STEP;/21X,1     B4040
     47H2=ALL TIME STEPS),8X,3H=  ,I4/13X,31HNPNTD  (PRINT OPTION-DISP.C     B4050
     5OEF./21X,24H0=NO; 1=FIRST TIME STEP;/21X,17H2=ALL TIME STEPS),8X,3     B4060
     6H=  ,I4/13X,32HNUMOBS (NO. OF OBSERVATION WELLS/21X,28HFOR HYDROGR     B4070
     7APH PRINTOUT) =  ,I4/13X,35HNREC   (NO. OF RECHARGE CELLS)   = ,I5     B4080
     8/13X,24HNCODES (FOR NODE IDENT.),9X,2H= ,I5/13X,32HNPNCHV (WRITE V     B4090
     9ELOCITIES-UNIT 7),1X,2H= ,I5/13X,36HNPDELC (PRINT OPT.-CONC. CHANG     B4100
     $E) =  ,I4)                                                             B4110
  910 FORMAT (1H0,10X,29HLOCATION OF OBSERVATION WELLS//17X,3HNO.,5X,1HX     B4120
     1,5X,1HZ/)                                                              B4130
  920 FORMAT (1H0,10X,28HLOCATION  OF  RECHARGE CELLS//11X,37HX   Z   RA     B4140
     1TE(IN CFS)  CONC. TDS CONC.)                                           B4150
  930 FORMAT (1H0,5X,37HNO. OF NODE IDENT. CODES SPECIFIED = ,I2)            B4160
  940 FORMAT (1H0,10X,41HTHE FOLLOWING ASSIGNMENTS HAVE BEEN MADE:/5X,4D     B4170
     1HCODE NO.     TDS CONC.          CONC.    )                           B4180
  950 FORMAT (1H ,5X,61H*** WARNING ***    PERM.EQ.0.0 AND NODEID.GT.0.0     B4190
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     1 AT NODE IX =,I4,6H, IZ =,I4)                                                    B4200
  960 FORMAT (1H ,5X,56H*** WARNING ***   PERM.EQ.0.0 AND PI.NE.0.0 AT N               B4210
     1ODE IX =,I4,6H, IZ =,I4)                                                        B4220
  970 FORMAT (1H ,5X,58H*** WARNING ***   PERM.EQ.0.0 AND RECH.NE.0.0 AT               B4230
     1 NODE IX =,I4,6H, IZ =,I4)                                                      B4240
  980 FORMAT (I1)                                                                     B4250
  990 FORMAT (9I4,3G5.0)                                                              B4260
 1000 FORMAT (1H1,5X,25HSTART PUMPING PERIOD NO. ,I2//2X,75HTHE FOLLOWIN              B4270
     1G TIME STEP, PUMPAGE, AND PRINT PARAMETERS HAVE BEEN REDEFINED:/)               B4280
 1010 FORMAT (1HO,14X,9HNTIM    = ,I4/15X,9HNPNT    = ,I4/15X,9HNITP    = ,          B4290
     1I4/15X,9HITMAX  = ,I4/15X,9HNREC    = ,I4/15X,9HNPNTMV = ,I4/15X,9H           B4300
     2NPNTVL = ,I4/15X,9HNPNTD  = ,I4/15X,9HNPDELC = ,I4/15X,9HNPNCHV =            B4310
     3,I4/15X,9HPINT    = ,F10.3/15X,9HTIMX    = ,F10.3/15X,9HTINIT  = ,F1        B4320
     40.3/)                                                                           B4330
 1020 FORMAT (1H1,5X,25HSTART PUMPING PERIOD NO. ,I2//2X,23HNO PARAMETER              B4340
     1S REDEFINED/)                                                                   B4350
 1030 FORMAT (1HO,28HINITIAL DENSITIES (LB/FT**3)/)                                   B4360
 1040 FORMAT (20F6.2)                                                                 B4370
 1050 FORMAT (1HO,34HINITIAL VISCOSITIES (LB*SEC/FT**2)/)                             B4380
 1060 FORMAT (4G10.3)                                                                 B4390
 1070 FORMAT (1HO,44HINITIAL TDS MAP - DENSITY-CONTROLLING SOLUTE/)                   B4400
      END                                                                             B4410-
      SUBROUTINE ITERAT                                                           C   10
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                         C   20
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO          C   30
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTMV,NPNTVL,NPNTD,N         C   40
     2PNCHV,NPDELC,ICHK,NCONST                                                    C   50
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500),          C   60
     1IXOBS(5),IZOBS(5)                                                           C   70
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24          C   80
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR         C   90
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),AOPT(20),TITLE(10),ANFCTR,X         C  100
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL             C  110
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24,          C  120
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5,         C  130
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C         C  140
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI         C  150
     4S,DLTRAT,CSTORM,CSTORT,DMOLEC                                               C  160
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VYBDY(24,20),SUMTDS(24,20),          C  170
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)                C  180
      COMMON /BALM/ TOTLQ,TOTLQI,TPIN,TPOUT                                       C  190
      COMMON /XINV/ DXINV,DZINV,ARINV,PORINV                                      C  200
      COMMON /DENVIS/ DEN1,DEN2,VIS1,VIS2                                         C  210
      COMMON /CNCHNG/ CNCHCK(24,20),CTOL                                          C  220
      DIMENSION DEL(24,20), ETA(24,20), V(24,20), XI(24,20), IORDER(21),          C  230
     1 RHOP(20), TEMP(20), TEST3(201)                                             C  240
      DATA IORDER/1,2,3,4,5,1,2,3,4,5,11*1/                                       C  250
      HMAX=1.0                                                                    C  260
      DO 30 IX=1,NX                                                               C  270
      DO 30 IZ=1,NZ                                                               C  280
      IF (PERM(IX,IZ).EQ.0.0) GO TO 30                                            C  290
      CNCHCK(IX,IZ)=TDS(IX,IZ)                                                    C  300
C      --- REASSIGN DENSITIES AND VISCOSITIES ---                                 C  310
      DTEMP=DENS(IX,IZ)                                                           C  320
      DENS(IX,IZ)=DEN1*TDS(IX,IZ)+DEN2                                            C  330
      IF (REC(IX,IZ).GT.0.0) REC(IX,IZ)=REC(IX,IZ)*DENS(IX,IZ)/DTEMP              C  340
      IF (VIS1.NE.0.0) GO TO 20                                                   C  350
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      IF (TDS(IX,IZ).GT.20000) GO TO 10                                  C 360
      VISC(IX,IZ)=3.45E-11*TDS(IX,IZ)+2.089E-05                          C 370
      GO TO 30                                                           C 380
   10 VISC(IX,IZ)=4.733E-11*TDS(IX,IZ)+2.063E-05                         C 390
      GO TO 30                                                           C 400
   20 VISC(IX,IZ)=VIS1*TDS(IX,IZ)+VIS2                                   C 410
   30 CONTINUE                                                           C 420
      DO 80 IZ=2,NNZ                                                     C 430
      DO 80 IX=2,NNX                                                     C 440
      IF (PERM(IX,IZ).EQ.0.0) GO TO 80                                   C 450
      FF1=PERM(IX,IZ)/VISC(IX,IZ)                                        C 460
      F1=FF1*DENS(IX,IZ)                                                 C 470
      IF (PERM(IX+1,IZ).EQ.0.0) GO TO 40                                 C 480
      FF2=PERM(IX+1,IZ)/VISC(IX+1,IZ)                                    C 490
      F2=FF2*DENS(IX+1,IZ)                                               C 500
      GO TO 50                                                           C 510
   40 FF2=0.0                                                            C 520
      F2=0.0                                                             C 530
   50 IF (PERM(IX,IZ+1).EQ.0.0) GO TO 60                                 C 540
      FF3=PERM(IX,IZ+1)/VISC(IX,IZ+1)                                    C 550
      F3=FF3*DENS(IX,IZ+1)                                               C 560
      GO TO 70                                                           C 570
   60 FF3=0.0                                                            C 580
      F3=0.0                                                             C 590
   70 PMRX(IX,IZ,1)=2.0*F1*F2/((F1+F2)*XDEL)                             C 600
      PMRX(IX,IZ,2)=2.0*F1*F3/((F1+F3)*ZDEL)                             C 610
      PMRX(IX,IZ,2)=PMRX(IX,IZ,2)*ANFCTR                                 C 620
      PMRX(IX,IZ,3)=2.0*FF1*FF2/(FF1+FF2)                                C 630
      PMRX(IX,IZ,4)=2.0*FF1*FF3/(FF1+FF3)                                C 640
      PMRX(IX,IZ,4)=PMRX(IX,IZ,4)*ANFCTR                                 C 650
      DENS1=(DENS(IX,IZ+1)+DENS(IX,IZ))*0.500                            C 660
      DENS2=(DENS(IX,IZ)+DENS(IX,IZ-1))*0.500                            C 670
      GTERM(IX,IZ)=PMRX(IX,IZ,2)*DENS1-PMRX(IX,IZ-1,2)*DENS2             C 680
   80 CONTINUE                                                           C 690
C                                                                        C 700
C     COMPUTE AND PRINT ITERATION PARAMETERS                             C 710
C                                                                        C 720
      PQIN=0.0                                                           C 730
      PQOUT=0.0                                                          C 740
      KOUNT=-1                                                           C 750
      DO 90 I=1,NX                                                       C 760
      DO 90 J=1,NZ                                                       C 770
      PR(I,J)=PK(I,J)                                                    C 780
   90 CONTINUE                                                           C 790
      IF (INT.NE.1) GO TO 120                                            C 800
C                                                                        C 810
C     ---INITIALIZE ORDER OF ITERATION PARAMETERS                        C 820
C                                                                        C 830
      IN01=NX-1                                                          C 840
      JN01=NZ-1                                                          C 850
      I2=IN01-1                                                          C 860
      J2=JN01-1                                                          C 870
      L2=NITP/2                                                          C 880
      PL2=L2-1                                                           C 890
C                                                                        C 900
C     COMPUTE MAXIMUM PARAMETER FOR PROBLEM                              C 910
C                                                                        C 920
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      DX=(1./NX)**2                                                          C 930
      DZ=(1./NZ)**2                                                          C 940
      W=1.0D0-DMIN1(2.0D0*DX/(1.0D0+ANFCTR*DX/DZ),2.0D0*DZ/(1.0D0+DZ/(AN     C 950
     1FCTR*DX)))                                                             C 960
C                                                                            C 970
C      --- COMPUTE PARAMETERS IN GEOMETRIC SEQUENCE ---                      C 980
C                                                                            C 990
      PJ=-1.                                                                 C1000
      DO 100 I=1,L2                                                          C1010
      PJ=PJ+1                                                                C1020
  100 TEMP(I)=1.0D0-(1.0D0-W)**(PJ/PL2)                                      C1030
C                                                                            C1040
C      --- ORDER SEQUENCE OF PARAMETERS ---                                  C1050
C                                                                            C1060
      DO 110 J=1,NITP                                                        C1070
  110 RHOP(J)=TEMP(IORDER(J))                                                C1080
      IF (IMOV.EQ.0) WRITE (6,250) HMAX,NITP,(RHOP(J),J=1,NITP)              C1090
C                                                                            C1100
C      INITIALIZE DATA FOR A NEW ITERATION                                   C1110
C                                                                            C1120
  120 KOUNT=KOUNT+1                                                          C1130
      IF (KOUNT.LE.ITMAX) GO TO 130                                          C1140
      WRITE (6,290)                                                          C1150
      CALL OUTPT                                                             C1160
      WRITE (6,260) (TEST3(I),I=1,KOUNT)                                     C1170
      STOP                                                                   C1180
  130 IF (MOD(KOUNT,NITP)) 140,140,150                                       C1190
C                                                                            C1200
C      INITIALIZE DATA FOR A NEW ITERATION                                   C1210
C                                                                            C1220
  140 NTH=0                                                                  C1230
  150 NTH=NTH+1                                                              C1240
      W=RHOP(NTH)                                                            C1250
      TEST3(KOUNT+1)=0                                                       C1260
      TEST=0                                                                 C1270
      DO 160 I=1,NX                                                          C1280
      DO 160 J=1,NZ                                                          C1290
      DEL(I,J)=0                                                             C1300
      ETA(I,J)=0                                                             C1310
      V(I,J)=0                                                               C1320
  160 XI(I,J)=0                                                              C1330
      BIGI=0                                                                 C1340
      RHO=S/TIM(N)                                                           C1350
C                                                                            C1360
C      CHOOSE SIP NORMAL OR REVERSE ALGORITHM                                C1370
C                                                                            C1380
      IF (MOD(KOUNT,2)) 170,220,170                                          C1390
C                                                                            C1400
C      ..................................................................    C1410
C      ---ORDER EQUATIONS WITH ROW 1 FIRST- 3X3 EXAMPLE:                     C1420
C                        1 2 3                                               C1430
C                        4 5 6                                               C1440
C                        7 8 9                                               C1450
C      ..................................................................    C1460
  170 DO 180 J=2,JN01                                                        C1470
      DO 180 I=2,IN01                                                        C1480
C                                                                            C1490
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C       --- SKIP COMPUTATIONS IF NODE IS OUTSIDE AQUIFER BOUNDRY---          C1500
        IF (PERM(I,J).EQ.0.) GO TO 180                                       C1510
C                                                                            C1520
C       --- COMPUTE COEFFICIENTS---                                          C1530
C                                                                            C1540
        D=PMRX(I-1,J,1)/XDEL                                                 C1550
        F=PMRX(I,J,1)/XDEL                                                   C1560
        B=PMRX(I,J-1,2)/ZDEL                                                 C1570
        H=PMRX(I,J,2)/ZDEL                                                   C1580
        CH=DEL(I,J-1)*B/(1.+W*DEL(I,J-1))                                    C1590
        GH=ETA(I-1,J)*D/(1.+W*ETA(I-1,J))                                    C1600
C                                                                            C1610
C       ---SIP 'NORMAL' ALGORITHM ---                                        C1620
C       ---FOWARD SUBSTITUTE, COMPUTING INTERMEDIATE VECTOR V---             C1630
C                                                                            C1640
        E=-B-D-F-H-RHO-VPRM(I,J)                                             C1650
        BH=B-W*CH                                                            C1660
        DH=D-W*GH                                                            C1670
        EH=E+W*(CH+GH)                                                       C1680
        FH=F-W*CH                                                            C1690
        HH=H-W*GH                                                            C1700
        ALFA=BH                                                              C1710
        BEDA=DH                                                              C1720
        GAMA=EH-ALFA*ETA(I,J-1)-BEDA*DEL(I-1,J)                              C1730
        DEL(I,J)=FH/GAMA                                                     C1740
        ETA(I,J)=HH/GAMA                                                     C1750
        QL=-VPRM(I,J)*(PI(I,J)+DENS(I,J)*ELEV(I,J))                          C1760
        RES=-D*PK(I-1,J)-F*PK(I+1,J)-H*PK(I,J+1)-B*PK(I,J-1)-E*PK(I,J)-RHO   C1770
       1*PR(I,J)+QL+REC(I,J)+GTERM(I,J)                                      C1780
        V(I,J)=(HMAX*RES-ALFA*V(I,J-1)-BEDA*V(I-1,J))/GAMA                   C1790
  180 CONTINUE                                                               C1800
C                                                                            C1810
C       ---BACK SUBSTITUTE FOR VECTOR XI ---                                 C1820
C                                                                            C1830
        DO 190 J=1,J2                                                        C1840
        J3=NZ-J                                                              C1850
        DO 190 I=1,I2                                                        C1860
        I3=NX-I                                                              C1870
        IF (PERM(I3,J3).EQ.0.) GO TO 190                                     C1880
        XI(I3,J3)=V(I3,J3)-DEL(I3,J3)*XI(I3+1,J3)-ETA(I3,J3)*XI(I3,J3+1)     C1890
C                                                                            C1900
C       --- COMPARE MAGNITUDE OF CHANGE WITH CLOSURE CRITERION---            C1910
C                                                                            C1920
        TCHK=DABS(XI(I3,J3))                                                 C1930
        IF (TCHK.GT.BIGI) BIGI=TCHK                                          C1940
        PK(I3,J3)=PK(I3,J3)+XI(I3,J3)                                        C1950
  190 CONTINUE                                                               C1960
  200 IF (BIGI.GT.TOL) TEST=1                                                C1970
        TEST3(KOUNT+1)=BIGI                                                  C1980
        IF (TEST.EQ.1.) GO TO 120                                            C1990
        DO 210 IZ=1,NZ                                                       C2000
        DO 210 IX=1,NX                                                       C2010
        IF (PERM(IX,IZ).EQ.0.0) GO TO 210                                    C2020
        PTQ(IX,IZ)=REC(IX,IZ)                                                C2030
        IF (REC(IX,IZ).LT.0.0) PQIN=PQIN+REC(IX,IZ)*VOL                      C2040
        IF (REC(IX,IZ).GT.0.0) PQOUT=PQOUT+REC(IX,IZ)*VOL                    C2050
C       ---COMPUTE LEAKAGE FOR MASS BALANCE---                               C2060
```

```
      IF (VPRM(IX,IZ).EQ.0.0) GO TO 210                                  C2070
      DELQ=VPRM(IX,IZ)*(PI(IX,IZ)-PK(IX,IZ)+DENS(IX,IZ)*ELEV(IX,IZ))    C2080
      PTQ(IX,IZ)=PTQ(IX,IZ)-DELQ                                         C2090
      IF (DELQ.GT.0.0) TOTLQI=TOTLQI+DELQ*TIM(N)                         C2100
      IF (DELQ.LT.0.0) TOTLQ=TOTLQ+DELQ*TIM(N)                           C2110
  210 CONTINUE                                                           C2120
      TPIN=PQIN*TIM(N)+TPIN                                              C2130
      TPOUT=PQOUT*TIM(N)+TPOUT                                           C2140
C                                                                        C2150
      WRITE (6,270) N                                                    C2160
      WRITE (6,280) KOUNT                                                C2170
C     ******************************************************************* C2180
      RETURN                                                             C2190
C     ******************************************************************* C2200
C                                                                        C2210
C                                                                        C2220
C      ..................................................................C2230
C      ---ORDER EQUATIONS WITH THE LAST ROW FIRST- 3X3 EXAMPLE:          C2240
C               7 8 9                                                    C2250
C               4 5 6                                                    C2260
C               1 2 3                                                    C2270
C      ..................................................................C2280
  220 DO 230 JJ=1,J2                                                     C2290
      J=NZ-JJ                                                            C2300
      DO 230 I=2,IN01                                                    C2310
C                                                                        C2320
C      --- SKIP COMPUTATIONS IF NODE IS OUTSIDE OF AQUIFER BOUNDRY---    C2330
      IF (PERM(I,J).EQ.0.) GO TO 230                                     C2340
C                                                                        C2350
C      ---COMPUTE COEFFICIENTS---                                        C2360
      D=PMRX(I-1,J,1)/XDEL                                               C2370
      F=PMRX(I,J,1)/XDEL                                                 C2380
      B=PMRX(I,J-1,2)/ZDEL                                               C2390
      H=PMRX(I,J,2)/ZDEL                                                 C2400
C                                                                        C2410
C      --- SIP 'REVERSE' ALGORITHM---                                    C2420
C      --- FOWARD SUBSTITUTE, COMPUTING INTERMEDIATE VECTOR V---         C2430
C                                                                        C2440
      E=-B-D-F-H-RHO-VPRM(I,J)                                           C2450
      CH=DEL(I,J+1)*H/(1.+W*DEL(I,J+1))                                  C2460
      GH=ETA(I-1,J)*D/(1.+W*ETA(I-1,J))                                  C2470
      BH=H-W*CH                                                          C2480
      DH=D-W*GH                                                          C2490
      EH=E+W*(CH+GH)                                                     C2500
      FH=F-W*CH                                                          C2510
      HH=B-W*GH                                                          C2520
      ALFA=BH                                                            C2530
      BEDA=DH                                                            C2540
      GAMA=EH-ALFA*ETA(I,J+1)-BEDA*DEL(I-1,J)                            C2550
      DEL(I,J)=FH/GAMA                                                   C2560
      ETA(I,J)=HH/GAMA                                                   C2570
      QL=-VPRM(I,J)*(PI(I,J)+DENS(I,J)*ELEV(I,J))                        C2580
      RES=-D*PK(I-1,J)-F*PK(I+1,J)-H*PK(I,J+1)-B*PK(I,J-1)-E*PK(I,J)-RHO C2590
     1*PR(I,J)+QL+REC(I,J)+GTERM(I,J)                                    C2600
      V(I,J)=(HMAX*RES-ALFA*V(I,J+1)-BEDA*V(I-1,J))/GAMA                 C2610
  230 CONTINUE                                                           C2620
C                                                                        C2630
```

```
C       --- BACK SUBSTITUTE FOR VECTOR XI ---                                C2640
      DO 240 J=2,JNO1                                                       C2650
      DO 240 I3=1,I2                                                        C2660
      I=NX-I3                                                               C2670
      IF (PERM(I,J).EQ.0.) GO TO 240                                        C2680
      XI(I,J)=V(I,J)-DEL(I,J)*XI(I+1,J)-ETA(I,J)*XI(I,J-1)                  C2690
C                                                                           C2700
C       --- COMPARE MAGNITUDE OF CHANGE WITH CLOSURE CRITERION ---          C2710
C                                                                           C2720
      TCHK=DABS(XI(I,J))                                                    C2730
      IF (TCHK.GT.BIGI) BIGI=TCHK                                           C2740
      PK(I,J)=PK(I,J)+XI(I,J)                                               C2750
  240 CONTINUE                                                              C2760
      GO TO 200                                                             C2770
C                                                                           C2780
  250 FORMAT (1X,6HBETA= ,F4.2,/,1X,I3,23H ITERATIONS PARAMETERS:,6(/1X,    C2790
     16E15.6))                                                              C2800
  260 FORMAT (1X,39HMAXIMUM HEAD CHANGE FOR EACH ITERATION:,20(/,1X,10(F    C2810
     112.5)))                                                               C2820
  270 FORMAT (1H0//3X,4HN = ,I4)                                            C2830
  280 FORMAT (1X,22HNUMBER OF ITERATIONS= ,I3)                              C2840
  290 FORMAT (1H0,5X,53H*** EXECUTION TERMINATED -- MAX # ITERATIONS EXC    C2850
     1EEDED/26X,21HFINAL OUTPUT FOLLOWS:)                                   C2860
      END                                                                   C2870-
      SUBROUTINE GENPT                                                      D  10
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                   D  20
      INTEGER *2PTID                                                        D  30
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO    D  40
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTHV,NPNTVL,NPNTD,N    D  50
     2PNCHV,NPDELC,ICHK,NCONST                                              D  60
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500),    D  70
     1IXOBS(5),IZOBS(5)                                                     D  80
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24    D  90
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR    D 100
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),ADPT(20),TITLE(10),ANFCTR,X    D 110
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL       D 120
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24,    D 130
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5,    D 140
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C    D 150
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI    D 160
     4S,DLTRAT,CSTORM,CSTORT,DMOLEC                                         D 170
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VYBDY(24,20),SUMTDS(24,20),    D 180
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)          D 190
      COMMON /CHMP/ PTID(6400)                                              D 200
      DIMENSION RPT(16), RNT(16), RP(16), RN(16), IPT(16), RPT2(16), RNT    D 210
     12(16), RP2(16), RN2(16)                                               D 220
C     ***************************************************************     D 230
      F1=0.30                                                               D 240
      F2=1.0/3.0                                                            D 250
      IF (NPTPND.EQ.4) F1=0.25                                              D 260
      IF (NPTPND.EQ.9) F1=1.0/3.0                                           D 270
      IF (NPTPND.EQ.8) F2=0.25                                              D 280
      IF (NPTPND.EQ.16) F1=0.25                                             D 290
      IF (NPTPND.EQ.16) F2=0.125                                            D 300
      NCHK=NPTPND                                                           D 310
      IF (NPTPND.EQ.5.OR.NPTPND.EQ.9) NCHK=NPTPND-1                         D 320
      IF (TEST.GT.98.) GO TO 10                                             D 330
```

```
C     ******************************************************************      D 340
C     ---INITIALIZE VALUES---                                                 D 350
      STORM=0.0                                                               D 360
      STORT=0.0                                                               D 370
      FLTOT=0.0                                                               D 380
      FLTIN=0.0                                                               D 390
      CMSIN=0.0                                                               D 400
      CMSOUT=0.0                                                              D 410
      FLMIN=0.0                                                               D 420
      FLMOT=0.0                                                               D 430
      SUMIO=0.0                                                               D 440
C     ******************************************************************      D 450
   10 DO 20 IN=1,NPMAX                                                        D 460
      PTID(IN)=0                                                              D 470
      PTWT(IN)=1.0                                                            D 480
      DO 20 ID=1,4                                                            D 490
   20 PART(ID,IN)=0.0                                                         D 500
      DO 30 IA=1,16                                                           D 510
      RP(IA)=0.0                                                              D 520
      RN(IA)=0.0                                                              D 530
      RPT(IA)=0.0                                                             D 540
      RNT(IA)=0.0                                                             D 550
      RP2(IA)=0.0                                                             D 560
      RN2(IA)=0.0                                                             D 570
      RPT2(IA)=0.0                                                            D 580
      RNT2(IA)=0.0                                                            D 590
   30 IPT(IA)=0                                                               D 600
C     ---SET UP LIMBO ARRAY---                                                D 610
      DO 40 IN=1,500                                                          D 620
   40 LIMBO(IN)=0.0                                                           D 630
      IND=1                                                                   D 640
      DO 50 IL=1,500,2                                                        D 650
      LIMBO(IL)=IND                                                           D 660
   50 IND=IND+1                                                               D 670
C     ******************************************************************      D 680
C     ---INSERT PARTICLES---                                                  D 690
      DO 720 IX=2,NNX                                                         D 700
      DO 720 IZ=2,NNZ                                                         D 710
      IF (PERM(IX,IZ).EQ.0.0) GO TO 720                                       D 720
      KR=0                                                                    D 730
      KR2=0                                                                   D 740
      TEST2=0.0                                                               D 750
      METH=1                                                                  D 760
      NPCELL(IX,IZ)=0                                                         D 770
      NPOLD(IX,IZ)=NPTPND                                                     D 780
      C1=CONC(IX,IZ)                                                          D 790
      C2=TDS(IX,IZ)                                                           D 800
      IF (C1.LE.1.0E-05) TEST2=1.0                                            D 810
      IF (VPRM(IX,IZ).GT.0.00) TEST2=1.0                                      D 820
      IF (PERM(IX+1,IZ+1).EQ.0.0.OR.PERM(IX+1,IZ-1).EQ.0.0.OR.PERM(IX-1,      D 830
     1IZ+1).EQ.0.0.OR.PERM(IX-1,IZ-1).EQ.0.0) TEST2=1.0                       D 840
      IF ((PERM(IX,IZ+1).EQ.0.0.OR.PERM(IX,IZ-1).EQ.0.0.OR.PERM(IX+1,IZ)      D 850
     1.EQ.0.0.OR.PERM(IX-1,IZ).EQ.0.0).AND.NPTPND.GT.5) TEST2=1.0             D 860
      CNODE=C1*(1.0-F1)                                                       D 870
      CNODE2=C2*(1.0-F1)                                                      D 880
      IF (TEST.LT.98.0.OR.TEST2.GT.0.0) GO TO 70                              D 890
      SUM=CONC(IX+1,IZ)+CONC(IX-1,IZ)+CONC(IX,IZ+1)+CONC(IX,IZ-1)             D 900
```

```
      IF (NCHK.EQ.4) GO TO 60
      SUM=SUM+CONC(IX+1,IZ+1)+CONC(IX+1,IZ-1)+CONC(IX-1,IZ+1)+CONC(IX-1,  D 910
     1IZ-1)                                                               D 920
   60 AVC=SUM/NCHK                                                        D 930
      IF (AVC.GT.C1) METH=2                                               D 940
C                                                                         D 950
C        ---PUT 4 PARTICLES ON CELL DIAGONALS---                          D 960
   70 DO 250 IT=1,2                                                       D 970
      EVET=(-1.0)**IT                                                     D 980
      DO 250 IS=1,2                                                       D 990
      EVES=(-1.0)**IS                                                     D1000
      IF (NPTPND.EQ.16) GO TO 80                                          D1010
      PART(1,IND)=IX+F1*EVET                                              D1020
      PART(2,IND)=IZ+F1*EVES                                              D1030
      PART(2,IND)=-PART(2,IND)                                            D1040
      PART(3,IND)=C2                                                      D1050
      PART(4,IND)=C1                                                      D1060
      KR=KR+1                                                             D1070
      IPT(KR)=IND                                                         D1080
      PTID(IND)=KR                                                        D1090
      GO TO 90                                                            D1100
   80 IF (TEST.LT.98.0.OR.TEST2.GT.0.0) GO TO 200                         D1110
   90 IF (TEST.LT.98.0.OR.TEST2.GT.0.0) GO TO 240                         D1120
      IXD=IX+EVET                                                         D1130
      IZD=IZ+EVES                                                         D1140
      IF (METH.EQ.2) GO TO 100                                            D1150
      PARTC=CNODE+CONC(IXD,IZD)*F1                                        D1160
      PARTC2=CNODE2+TDS(IX,IZ)*F1                                         D1170
      GO TO 110                                                           D1180
  100 PARTC=2.0*C1*CONC(IXD,IZD)/(C1+CONC(IXD,IZD))                       D1190
      PARTC2=2.0*C2*TDS(IXD,IZD)/(C2+TDS(IXD,IZD))                        D1200
  110 IF (C1-CONC(IXD,IZD)) 120,130,140                                   D1210
  120 RPT(KR)=CONC(IXD,IZD)-PARTC                                         D1220
      RNT(KR)=C1-PARTC                                                    D1230
      GO TO 150                                                           D1240
  130 RPT(KR)=0.0                                                         D1250
      RNT(KR)=0.0                                                         D1260
      GO TO 150                                                           D1270
  140 RPT(KR)=C1-PARTC                                                    D1280
      RNT(KR)=CONC(IXD,IZD)-PARTC                                         D1290
  150 IF (C2-TDS(IXD,IZD)) 160,170,180                                    D1300
  160 RPT2(KR)=TDS(IXD,IZD)-PARTC2                                        D1310
      RNT2(KR)=C2-PARTC2                                                  D1320
      GO TO 190                                                           D1330
  170 RPT2(KR)=0.0                                                        D1340
      RNT2(KR)=0.0                                                        D1350
      GO TO 190                                                           D1360
  180 RPT2(KR)=C2-PARTC2                                                  D1370
      RNT2(KR)=TDS(IXD,IZD)-PARTC2                                        D1380
  190 IF (NPTPND.EQ.16) GO TO 200                                         D1390
      PART(3,IND)=PARTC2                                                  D1400
      PART(4,IND)=PARTC                                                   D1410
      RP2(KR)=RPT2(KR)                                                    D1420
      RN2(KR)=RNT2(KR)                                                    D1430
      RP(KR)=RPT(KR)                                                      D1440
      RN(KR)=RNT(KR)                                                      D1450
      GO TO 240                                                           D1460
                                                                          D1470
```

```
  200 DO 230 ITT=1,2                                                    D1480
      EVET2=(-1.0)**ITT                                                 D1490
      DO 230 ISS=1,2                                                    D1500
      EVES2=(-1.0)**ISS                                                 D1510
      PART(1,IND)=(IX+F1*EVET)+F2*EVET2                                 D1520
      PART(2,IND)=(IZ+F1*EVES)+F2*EVES2                                 D1530
      PART(2,IND)=-PART(2,IND)                                          D1540
      KR2=KR2+1                                                         D1550
      IF (TEST.LT.98.0.OR.TEST2.GT.0.0) GO TO 210                       D1560
      PART(3,IND)=PARTC2                                                D1570
      PART(4,IND)=PARTC                                                 D1580
      RP(KR2)=RPT(KR)                                                   D1590
      RN(KR2)=RNT(KR)                                                   D1600
      RP2(KR2)=RPT2(KR)                                                 D1610
      RN2(KR2)=RNT2(KR)                                                 D1620
      IPT(KR2)=IND                                                      D1630
      GO TO 220                                                         D1640
  210 PART(3,IND)=C2                                                    D1650
      PART(4,IND)=C1                                                    D1660
  220 PTID(IND)=KR2                                                     D1670
      IND=IND+1                                                         D1680
  230 CONTINUE                                                          D1690
      GO TO 250                                                         D1700
  240 IND=IND+1                                                         D1710
  250 CONTINUE                                                          D1720
      IF (NPTPND.EQ.16) GO TO 480                                       D1730
      IF (NPTPND.EQ.5.OR.NPTPND.EQ.9) GO TO 260                         D1740
      GO TO 270                                                         D1750
C        ---PUT ONE PARTICLE AT CENTER OF CELL---                       D1760
  260 PART(1,IND)=IX                                                    D1770
      PART(2,IND)=-IZ                                                   D1780
      PART(3,IND)=C2                                                    D1790
      PART(4,IND)=C1                                                    D1800
      PTID(IND)=5                                                       D1810
      IND=IND+1                                                         D1820
C        ---PLACE NORTH, SOUTH, EAST, AND WEST PARTICLES---             D1830
  270 IF (NPTPND.LT.8) GO TO 480                                        D1840
      CNODE=C1*(1.0-F2)                                                 D1850
      CNODE2=C2*(1.0-F2)                                                D1860
      DO 470 IT=1,2                                                     D1870
      EVET=(-1.0)**IT                                                   D1880
      PART(1,IND)=IX+F2*EVET                                            D1890
      PART(2,IND)=-IZ                                                   D1900
      PART(3,IND)=C2                                                    D1910
      PART(4,IND)=C1                                                    D1920
      IF (EVET.LT.0) PTID(IND)=6                                        D1930
      IF (EVET.GT.0) PTID(IND)=8                                        D1940
      IF (TEST.LT.98.0.OR.TEST2.GT.0.0) GO TO 370                       D1950
      IXD=IX+EVET                                                       D1960
      KR=KR+1                                                           D1970
      IPT(KR)=IND                                                       D1980
      IF (METH.EQ.2) GO TO 280                                          D1990
      PART(4,IND)=CNODE+CONC(IXD,IZ)*F2                                 D2000
      PART(3,IND)=CNODE2+TDS(IXD,IZ)*F2                                 D2010
      GO TO 290                                                         D2020
  280 PART(4,IND)=2.0*C1*CONC(IXD,IZ)/(C1+CONC(IXD,IZ))                 D2030
      PART(3,IND)=2.0*C2*TDS(IXD,IZ)/(C2+TDS(IXD,IZ))                   D2040
```

```
  290 IF (C1-CONC(IXD,IZ)) 300,310,320
  300 RP(KR)=CONC(IXD,IZ)-PART(4,IND)                                    D2050
      RN(KR)=C1-PART(4,IND)                                              D2060
      GO TO 330                                                          D2070
  310 RP(KR)=0.0                                                         D2080
      RN(KR)=0.0                                                         D2090
      GO TO 330                                                          D2100
  320 RP(KR)=C1-PART(4,IND)                                              D2110
      RN(KR)=CONC(IXD,IZ)-PART(4,IND)                                    D2120
  330 IF (C2-TDS(IXD,IZ)) 340,350,360                                    D2130
  340 RP2(KR)=TDS(IXD,IZ)-PART(3,IND)                                    D2140
      RN2(KR)=C2-PART(3,IND)                                             D2150
      GO TO 370                                                          D2160
  350 RP2(KR)=0.0                                                        D2170
      RN2(KR)=0.0                                                        D2180
      GO TO 370                                                          D2190
  360 RP2(KR)=C2-PART(3,IND)                                             D2200
      RN2(KR)=TDS(IXD,IZ)-PART(3,IND)                                    D2210
  370 IND=IND+1                                                          D2220
      PART(1,IND)=IX                                                     D2230
      PART(2,IND)=IZ+F2*EVET                                             D2240
      PART(2,IND)=-PART(2,IND)                                           D2250
      PART(3,IND)=C2                                                     D2260
      PART(4,IND)=C1                                                     D2270
      IF (EVET.LT.0) PTID(IND)=7                                         D2280
      IF (EVET.GT.0) PTID(IND)=9                                         D2290
      IF (TEST.LT.98.0.OR.TEST2.GT.0.0) GO TO 470                        D2300
      IZD=IZ+EVET                                                        D2310
      KR=KR+1                                                            D2320
      IPT(KR)=IND                                                        D2330
      IF (METH.EQ.2) GO TO 380                                           D2340
      PART(4,IND)=CNODE+CONC(IX,IZD)*F2                                  D2350
      PART(3,IND)=CNODE2+TDS(IX,IZD)*F2                                  D2360
      GO TO 390                                                          D2370
  380 PART(4,IND)=2.0*C1*CONC(IX,IZD)/(C1+CONC(IX,IZD))                  D2380
      PART(3,IND)=2.0*C2*TDS(IX,IZD)/(C2+TDS(IX,IZD))                    D2390
  390 IF (C1-CONC(IX,IZD)) 400,410,420                                   D2400
  400 RP(KR)=CONC(IX,IZD)-PART(4,IND)                                    D2410
      RN(KR)=C1-PART(4,IND)                                              D2420
      GO TO 430                                                          D2430
  410 RP(KR)=0.0                                                         D2440
      RN(KR)=0.0                                                         D2450
      GO TO 430                                                          D2460
  420 RP(KR)=C1-PART(4,IND)                                              D2470
      RN(KR)=CONC(IX,IZD)-PART(4,IND)                                    D2480
  430 IF (C2-TDS(IX,IZD)) 440,450,460                                    D2490
  440 RP2(KR)=TDS(IX,IZD)-PART(3,IND)                                    D2500
      RN2(KR)=C2-PART(3,IND)                                             D2510
      GO TO 470                                                          D2520
  450 RP2(KR)=0.0                                                        D2530
      RN2(KR)=0.0                                                        D2540
      GO TO 470                                                          D2550
  460 RP2(KR)=C2-PART(3,IND)                                             D2560
      RN2(KR)=TDS(IX,IZD)-PART(3,IND)                                    D2570
  470 IND=IND+1                                                          D2580
C                                                                        D2590
  480 IF (TEST.LT.98.0.OR.TEST2.GT.0.0) GO TO 720                        D2600
                                                                         D2610
```

```
      SUMPT=0.0                                                          D2620
C        ---COMPUTE CONC. GRADIENT WITHIN CELL---                        D2630
      IF (NCONST.LT.2) GO TO 600                                         D2640
      DO 490 KPT=1,NCHK                                                  D2650
      IK=IPT(KPT)                                                        D2660
  490 SUMPT=PART(4,IK)+SUMPT                                             D2670
      CBAR=SUMPT/NCHK                                                    D2680
C        ---CHECK MASS BALANCE WITHIN CELL AND ADJUST PT. CONCS.---       D2690
      SUMPT=0.0                                                          D2700
      IF (CBAR-C1) 500,600,520                                           D2710
  500 CRCT=1.0-(CBAR/C1)                                                 D2720
      IF (METH.EQ.1) CRCT=CBAR/C1                                        D2730
      DO 510 KPT=1,NCHK                                                  D2740
      IK=IPT(KPT)                                                        D2750
      PART(4,IK)=PART(4,IK)+RP(KPT)*CRCT                                 D2760
  510 SUMPT=SUMPT+PART(4,IK)                                             D2770
      CBARN=SUMPT/NCHK                                                   D2780
      GO TO 540                                                          D2790
  520 CRCT=1.0-(C1/CBAR)                                                 D2800
      IF (METH.EQ.1) CRCT=C1/CBAR                                        D2810
      DO 530 KPT=1,NCHK                                                  D2820
      IK=IPT(KPT)                                                        D2830
      PART(4,IK)=PART(4,IK)+RN(KPT)*CRCT                                 D2840
  530 SUMPT=SUMPT+PART(4,IK)                                             D2850
      CBARN=SUMPT/NCHK                                                   D2860
  540 IF (CBARN.EQ.C1) GO TO 600                                         D2870
C        ---CORRECT FOR OVERCOMPENSATION---                              D2880
      CRCT=C1/CBARN                                                      D2890
      DO 570 KPT=1,NCHK                                                  D2900
      IK=IPT(KPT)                                                        D2910
      PART(4,IK)=PART(4,IK)*CRCT                                         D2920
C        ---CHECK CONSTRAINTS---                                         D2930
      IF (PART(4,IK)-C1) 550,570,560                                     D2940
  550 CLIM=C1-RP(KPT)+RN(KPT)                                            D2950
      IF (PART(4,IK).LT.CLIM) GO TO 580                                  D2960
      GO TO 570                                                          D2970
  560 CLIM=C1+RP(KPT)-RN(KPT)                                            D2980
      IF (PART(4,IK).GT.CLIM) GO TO 580                                  D2990
  570 CONTINUE                                                           D3000
      GO TO 600                                                          D3010
  580 TEST2=1.0                                                          D3020
      DO 590 KPT=1,NCHK                                                  D3030
      IK=IPT(KPT)                                                        D3040
  590 PART(4,IK)=C1                                                      D3050
  600 DO 610 KPT=1,NCHK                                                  D3060
      IK=IPT(KPT)                                                        D3070
  610 SUMPT=PART(3,IK)+SUMPT                                             D3080
      CBAR=SUMPT/NCHK                                                    D3090
C        ---CHECK MASS BALANCE WITHIN CELL AND ADJUST PT. CONCS.---       D3100
      SUMPT=0.0                                                          D3110
      IF (CBAR-C2) 620,720,640                                           D3120
  620 CRCT=1.0-(CBAR/C2)                                                 D3130
      IF (METH.EQ.1) CRCT=CBAR/C2                                        D3140
      DO 630 KPT=1,NCHK                                                  D3150
      IK=IPT(KPT)                                                        D3160
      PART(3,IK)=PART(3,IK)+RP2(KPT)*CRCT                                D3170
  630 SUMPT=SUMPT+PART(3,IK)                                             D3180
```

```
      CBARN=SUMPT/NCHK
      GO TO 660                                                          D3190
  640 CRCT=1.0-(C2/CBAR)                                                 D3200
      IF (METH.EQ.1) CRCT=C2/CBAR                                        D3210
      DO 650 KPT=1,NCHK                                                  D3220
      IK=IPT(KPT)                                                        D3230
      PART(3,IK)=PART(3,IK)+RN2(KPT)*CRCT                                D3240
  650 SUMPT=SUMPT+PART(3,IK)                                             D3250
      CBARN=SUMPT/NCHK                                                   D3260
  660 IF (CBARN.EQ.C2) GO TO 720                                         D3270
C        ---CORRECT FOR OVERCOMPENSATION---                            D3280
      CRCT=C2/CBARN                                                      D3290
      DO 690 KPT=1,NCHK                                                  D3300
      IK=IPT(KPT)                                                        D3310
      PART(3,IK)=PART(3,IK)*CRCT                                         D3320
C        ---CHECK CONSTRAINTS---                                       D3330
      IF (PART(3,IK)-C2) 670,690,680                                     D3340
  670 CLIM=C2-RP2(KPT)+RN2(KPT)                                          D3350
      IF (PART(3,IK).LT.CLIM) GO TO 700                                  D3360
      GO TO 690                                                          D3370
  680 CLIM=C2+RP2(KPT)-RN2(KPT)                                          D3380
      IF (PART(3,IK).GT.CLIM) GO TO 700                                  D3390
  690 CONTINUE                                                           D3400
      GO TO 720                                                          D3410
  700 TEST2=1.0                                                          D3420
      DO 710 KPT=1,NCHK                                                  D3430
      IK=IPT(KPT)                                                        D3440
  710 PART(3,IK)=C2                                                      D3450
  720 CONTINUE                                                           D3460
      NP=IND                                                             D3470
      IF (INT.EQ.0) CALL CHMOT                                           D3480
C     ********************************************************************D3490
      RETURN                                                             D3500
C     ********************************************************************D3510
      END                                                                D3520
      SUBROUTINE VELO                                                    D3530-
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                E  10
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO E  20
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTMV,NPNTVL,NPNTD,N E  30
     2PNCHV,NPDELC,ICHK,NCONST                                           E  40
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500), E  50
     1IXOBS(5),IZOBS(5)                                                  E  60
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24 E  70
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR E  80
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),AOPT(20),TITLE(10),ANFCTR,X E  90
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL     E 100
      COMMON /DENVIS/ DEN1,DEN2,VIS1,VIS2                                E 110
      COMMON /XINV/ DXINV,DZINV,ARINV,PORINV                             E 120
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24, E 130
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5, E 140
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C E 150
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI E 160
     4S,DLTRAT,CSTORM,CSTORT,DMOLEC                                      E 170
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VZBDY(24,20),SUMTDS(24,20), E 180
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)       E 190
      COMMON /DIFUS/ DISP(24,20,4)                                       E 200
C     ********************************************************************E 210
                                                                         E 220
```

```
C      ---COMPUTE VELOCITIES AND STORE---                                    E 230
       VMAX=1.0E-10                                                          E 240
       VMAZ=1.0E-10                                                          E 250
       VMXBD=1.0E-10                                                         E 260
       VMZBD=1.0E-10                                                         E 270
       TMV=TIM(N)*1.0E5                                                      E 280
       LIM=0                                                                 E 290
       MAXX=0                                                                E 300
       MAXZ=0                                                                E 310
C                                                                            E 320
       DO 40 IX=1,NX                                                         E 330
       DO 40 IZ=1,NZ                                                         E 340
       WTFCTR(IX,IZ)=1.0                                                     E 350
       DO 10 IY=1,4                                                          E 360
   10  DISP(IX,IZ,IY)=0.0                                                    E 370
C                                                                            E 380
       IF (PERM(IX,IZ).EQ.0.0) GO TO 40                                      E 390
       DENSE=DENS(IX,IZ)                                                     E 400
       IF (VPRM(IX,IZ).GT.0.0.AND.(PI(IX,IZ).GT.PK(IX,IZ))) DENSE=DEN1*TD    E 410
      1SREC(IX,IZ)+DEN2                                                      E 420
       SLEAK=VPRM(IX,IZ)/DENS(IX,IZ)                                         E 430
       SLEAK=SLEAK*(PI(IX,IZ)-PK(IX,IZ)+DENS(IX,IZ)*ELEV(IX,IZ))             E 440
       DENSE=DENS(IX,IZ)                                                     E 450
       IF (REC(IX,IZ).LT.0.0) DENSE=DEN1*TDSREC(IX,IZ)+DEN2                  E 460
       DIV=SLEAK+REC(IX,IZ)/DENSE                                            E 470
C                                                                            E 480
C         ---VELOCITIES AT NODES---                                          E 490
C            ---X-DIRECTION---                                               E 500
       DPX=PK(IX-1,IZ)-PK(IX+1,IZ)                                           E 510
       IF (PERM(IX-1,IZ).EQ.0.0) DPX=PK(IX,IZ)-PK(IX+1,IZ)                   E 520
       IF (PERM(IX+1,IZ).EQ.0.0) DPX=PK(IX-1,IZ)-PK(IX,IZ)                   E 530
       IF (PERM(IX-1,IZ).EQ.0.0.AND.PERM(IX+1,IZ).EQ.0.0) DPX=0.0            E 540
       GRDX=DPX*DXINV*0.50                                                   E 550
       VX(IX,IZ)=PERM(IX,IZ)*GRDX*PORINV/VISC(IX,IZ)                         E 560
       ABVX=ABS(VX(IX,IZ))                                                   E 570
       IF (ABVX.GT.VMAX) VMAX=ABVX                                           E 580
C            ---Z-DIRECTION---                                               E 590
       DPZ=PK(IX,IZ-1)-PK(IX,IZ+1)                                           E 600
       DENSE=0.25*DENS(IX,IZ-1)+0.25*DENS(IX,IZ+1)+0.500*DENS(IX,IZ)         E 610
       GRDZ=DPZ*DZINV*0.500+DENSE                                            E 620
       IF (PERM(IX,IZ-1).EQ.0.0.AND.PERM(IX,IZ+1).EQ.0.0) GO TO 20           E 630
       IF (PERM(IX,IZ-1).EQ.0.0) DPZ=(PK(IX,IZ)-PK(IX,IZ+1))                 E 640
       IF (PERM(IX,IZ-1).EQ.0.0) DENSE=(DENS(IX,IZ)+DENS(IX,IZ+1))/2.0       E 650
       IF (PERM(IX,IZ-1).EQ.0.0) GRDZ=(DPZ*DZINV+DENSE)*0.500                E 660
       IF (PERM(IX,IZ+1).EQ.0.0) DPZ=(PK(IX,IZ-1)-PK(IX,IZ))                 E 670
       IF (PERM(IX,IZ+1).EQ.0.0) DENSE=(DENS(IX,IZ)+DENS(IX,IZ-1))/2.0       E 680
       IF (PERM(IX,IZ+1).EQ.0.0) GRDZ=(DPZ*DZINV+DENSE)*0.500                E 690
       GO TO 30                                                              E 700
   20  GRDZ=0.0                                                              E 710
   30  VZ(IX,IZ)=PERM(IX,IZ)*GRDZ*PORINV*ANFCTR/VISC(IX,IZ)                  E 720
       ABVZ=ABS(VZ(IX,IZ))                                                   E 730
       IF (ABVZ.GT.VMAZ) VMAZ=ABVZ                                           E 740
C                                                                            E 750
C         ---VELOCITIES AT CELL BOUNDARIES---                                E 760
       GRDX=(PK(IX,IZ)-PK(IX+1,IZ))*DXINV                                    E 770
       VXBDY(IX,IZ)=PMRX(IX,IZ,3)*GRDX*PORINV                                E 780
       DENSE=(DENS(IX,IZ)+DENS(IX,IZ+1))*0.500                               E 790
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```
      GRDZ=(PK(IX,IZ)-PK(IX,IZ+1))*DZINV+DENSE                          E 800
      VZBDY(IX,IZ)=PMRX(IX,IZ,4)*GRDZ*PORINV                            E 810
      ABVX=ABS(VXBDY(IX,IZ))                                            E 820
      ABVZ=ABS(VZBDY(IX,IZ))                                            E 830
      IF (ABVX.GT.VMXBD) VMXBD=ABVX                                     E 840
      IF (ABVZ.GT.VMZBD) VMZBD=ABVZ                                     E 850
C                                                                       E 860
      IF (DIV.GE.0.0) GO TO 40                                          E 870
      TDIV=POROS/DABS(DIV)                                              E 880
      IF (TDIV.GE.TMV) GO TO 40                                         E 890
      TMV=TDIV                                                          E 900
      MAXX=IX                                                           E 910
      MAXZ=IZ                                                           E 920
   40 CONTINUE                                                          E 930
C     ********************************************************************E 940
C     ---PRINT VELOCITIES---                                            E 950
      IF (NPNTVL.EQ.0) GO TO 100                                        E 960
      IF (NPNTVL.EQ.2) GO TO 50                                         E 970
      IF (NPNTVL.EQ.1.AND.N.EQ.1.AND.IMOV.EQ.0) GO TO 50                E 980
      GO TO 100                                                         E 990
   50 WRITE (6,400)                                                     E1000
      WRITE (6,410)                                                     E1010
      DO 60 IZ=1,NZ                                                     E1020
   60 WRITE (6,430) (VX(IX,IZ),IX=1,NX)                                 E1030
      WRITE (6,420)                                                     E1040
      DO 70 IZ=1,NZ                                                     E1050
   70 WRITE (6,430) (VXBDY(IX,IZ),IX=1,NX)                              E1060
      WRITE (6,440)                                                     E1070
      WRITE (6,410)                                                     E1080
      DO 80 IZ=1,NZ                                                     E1090
   80 WRITE (6,430) (VZ(IX,IZ),IX=1,NX)                                 E1100
      WRITE (6,420)                                                     E1110
      DO 90 IZ=1,NZ                                                     E1120
   90 WRITE (6,430) (VZBDY(IX,IZ),IX=1,NX)                              E1130
C     ---WRITE VELOCITIES TO UNIT 7---                                  E1140
  100 IF (NPNCHV.EQ.0) GO TO 130                                        E1150
      IF (NPNCHV.EQ.2) GO TO 110                                        E1160
      IF (NPNCHV.EQ.1.AND.N.EQ.1) GO TO 110                             E1170
      GO TO 130                                                         E1180
  110 WRITE (7,590) NX,NZ,XDEL,ZDEL,VMAX,VMAZ                           E1190
      DO 120 IZ=1,NZ                                                    E1200
      WRITE (7,600) (VX(IX,IZ),IX=1,NX)                                 E1210
  120 WRITE (7,600) (VZ(IX,IZ),IX=1,NX)                                 E1220
C     ********************************************************************E1230
C     ---COMPUTE NEXT TIME STEP---                                      E1240
  130 WRITE (6,470)                                                     E1250
      WRITE (6,480) VMAX,VMAZ                                           E1260
      WRITE (6,490) VMXBD,VMZBD                                         E1270
      TDELX=CELDIS*XDEL/VMAX                                            E1280
      TDELZ=CELDIS*ZDEL/VMAZ                                            E1290
      TDELXB=CELDIS*XDEL/VMXBD                                          E1300
      TDELZB=CELDIS*ZDEL/VMZBD                                          E1310
      TIMV=DMIN1(TDELX,TDELZ,TDELXB,TDELZB)                             E1320
      IF (DMAX1(VMAX,VMAZ,VMXBD,VMZBD).LE.1.0E-10) WRITE (6,650)        E1330
      WRITE (6,390) TMV,TIMV                                            E1340
      IF (TMV.LT.TIMV) GO TO 140                                        E1350
      LIM=-1                                                            E1360
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      GO TO 150                                                                 E1370
  140 TIMV=TMV                                                                  E1380
      LIM=1                                                                     E1390
  150 NTIMV=TIM(N)/TIMV                                                         E1400
      NMOV=NTIMV+1                                                              E1410
      WRITE (6,500) TIMV,NTIMV,NMOV                                             E1420
      TIMV=TIM(N)/NMOV                                                          E1430
      WRITE (6,450) TIM(N)                                                      E1440
      WRITE (6,460) TIMV                                                        E1450
C     ************************************************************************  E1460
C     --- CALCULATE THE WEIGHTING FACTORS FOR SOURCES AND SINKS ---             E1470
C                                                                               E1480
      DO 190 IX=1,NX                                                            E1490
      DO 190 IZ=1,NZ                                                            E1500
      IF (PERM(IX,IZ).EQ.0.0) GO TO 190                                         E1510
      IF (PTQ(IX,IZ).EQ.0.0) GO TO 190                                          E1520
      SUMQ=0.0                                                                  E1530
      SUMQIN=0.0                                                                E1540
      QSNK=0.0                                                                  E1550
      QSRC=0.0                                                                  E1560
      Q=VXBDY(IX-1,IZ)*POROS*ZDEL*WIDTH                                         E1570
      IF (Q.LT.0.0) SUMQ=SUMQ-Q                                                 E1580
      IF (Q.GT.0.0) SUMQIN=SUMQIN+Q                                             E1590
      Q=VXBDY(IX,IZ)*POROS*ZDEL*WIDTH                                           E1600
      IF (Q.GT.0.0) SUMQ=SUMQ+Q                                                 E1610
      IF (Q.LT.0.0) SUMQIN=SUMQIN-Q                                             E1620
      Q=VZBDY(IX,IZ-1)*POROS*XDEL*WIDTH                                         E1630
      IF (Q.LT.0.0) SUMQ=SUMQ-Q                                                 E1640
      IF (Q.GT.0.0) SUMQIN=SUMQIN+Q                                             E1650
      Q=VZBDY(IX,IZ)*POROS*XDEL*WIDTH                                           E1660
      IF (Q.GT.0.0) SUMQ=SUMQ+Q                                                 E1670
      IF (Q.LT.0.0) SUMQIN=SUMQIN-Q                                             E1680
      IF (REC(IX,IZ).GT.0.0) GO TO 180                                          E1690
  160 QSRC=QSRC-REC(IX,IZ)                                                      E1700
      IF (VPRM(IX,IZ).LE.0.0) GO TO 170                                         E1710
      QSRC=QSRC+VPRM(IX,IZ)*VOL*(PI(IX,IZ)-PK(IX,IZ)+DENS(IX,IZ)*ELEV(IX       E1720
     1,IZ))/DENS(IX,IZ)                                                         E1730
      IF (QSRC.LT.0.0) GO TO 180                                                E1740
  170 WTFCTR(IX,IZ)=QSRC/SUMQ                                                   E1750
      IF (WTFCTR(IX,IZ).GT.0.999) WTFCTR(IX,IZ)=1.0                             E1760
      GO TO 190                                                                 E1770
  180 QSNK=QSNK+REC(IX,IZ)                                                      E1780
      QSNK=QSNK-VOL*VPRM(IX,IZ)*(PI(IX,IZ)-PK(IX,IZ)+DENS(IX,IZ)*ELEV(IX       E1790
     1,IZ))/DENS(IX,IZ)                                                         E1800
      IF (QSNK.LT.0.0) GO TO 160                                                E1810
      WTFCTR(IX,IZ)=1.0-(QSNK/SUMQIN)                                           E1820
      IF (WTFCTR(IX,IZ).LT.0.001) WTFCTR(IX,IZ)=0.0                             E1830
  190 CONTINUE                                                                  E1840
C     WRITE (6,680)                                                             E1850
C     DO 136 IZ=1,NZ                                                            E1860
C 136 WRITE (6,690)  (WTFCTR(IX,IZ),IX=1,NX)                                    E1870
      IF (BETA.EQ.0.0.AND.DMOLEC.EQ.0.0) GO TO 270                              E1880
C     ************************************************************************  E1890
C     ---COMPUTE DISPERSION COEFFICIENTS---                                     E1900
      ALPHA=BETA                                                                E1910
      ALNG=ALPHA                                                                E1920
      TRAN=DLTRAT*ALPHA                                                         E1930
```

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      XX2=XDEL*XDEL                                                                 E1940
      ZZ2=ZDEL*ZDEL                                                                 E1950
      XZ2=4.0*XDEL*ZDEL                                                             E1960
      DO 210 IX=2,NNX                                                               E1970
      DO 210 IZ=2,NNZ                                                               E1980
      IF (PERM(IX,IZ).EQ.0.0) GO TO 210                                             E1990
      VXE=VXBDY(IX,IZ)                                                              E2000
      VZS=VZBDY(IX,IZ)                                                              E2010
      IF (PERM(IX+1,IZ).EQ.0.0) GO TO 200                                           E2020
C        ---FORWARD COEFFICIENTS: X-DIRECTION---                                    E2030
      VZE=(VZBDY(IX,IZ-1)+VZBDY(IX+1,IZ-1)+VZS+VZBDY(IX+1,IZ))/4.0                 E2040
      VXE2=VXE*VXE                                                                  E2050
      VZE2=VZE*VZE                                                                  E2060
      VMGE=SQRT(VXE2+VZE2)                                                          E2070
      IF (VMGE.LT.1.0E-20) GO TO 200                                                E2080
      DALN=ALNG*VMGE                                                                E2090
      DTRN=TRAN*VMGE                                                                E2100
      VMGE2=VMGE*VMGE                                                               E2110
C           ---XX COEFFICIENT---                                                    E2120
      DISP(IX,IZ,1)=(DALN*VXE2+DTRN*VZE2)/(VMGE2*XX2)                               E2130
C           ---XZ COEFFICIENT---                                                    E2140
      DISP(IX,IZ,3)=(DALN-DTRN)*VXE*VZE/(VMGE2*XZ2)                                 E2150
C        ---FORWARD COEFFICIENTS: Z-DIRECTION---                                    E2160
  200 IF (PERM(IX,IZ+1).EQ.0.0) GO TO 210                                           E2170
      VXS=(VXBDY(IX-1,IZ)+VXE+VXBDY(IX-1,IZ+1)+VXBDY(IX,IZ+1))/4.0                 E2180
      VZS2=VZS*VZS                                                                  E2190
      VXS2=VXS*VXS                                                                  E2200
      VMGS=SQRT(VXS2+VZS2)                                                          E2210
      IF (VMGS.LT.1.0E-20) GO TO 210                                                E2220
      DALN=ALNG*VMGS                                                                E2230
      DTRN=TRAN*VMGS                                                                E2240
      VMGS2=VMGS*VMGS                                                               E2250
C           ---ZZ COEFFICIENT---                                                    E2260
      DISP(IX,IZ,2)=(DALN*VZS2+DTRN*VXS2)/(VMGS2*ZZ2)                               E2270
C           ---ZX COEFFICIENT---                                                    E2280
      DISP(IX,IZ,4)=(DALN-DTRN)*VXS*VZS/(VMGS2*XZ2)                                 E2290
  210 CONTINUE                                                                      E2300
C     ********************************************************************        E2310
C     ---ADJUST CROSS-PRODUCT TERMS FOR ZERO THICKNESS---                         E2320
      DO 240 IX=2,NNX                                                               E2330
      DO 240 IZ=2,NNZ                                                               E2340
      IF (PERM(IX,IZ).EQ.0.0) GO TO 230                                             E2350
      IF (PERM(IX+1,IZ).EQ.0.0) GO TO 220                                           E2360
      DISP(IX,IZ,1)=DISP(IX,IZ,1)+DMOLEC/XX2                                        E2370
  220 IF (PERM(IX,IZ+1).EQ.0.0) GO TO 230                                           E2380
      DISP(IX,IZ,2)=DISP(IX,IZ,2)+DMOLEC/ZZ2                                        E2390
  230 IF (PERM(IX,IZ+1).EQ.0.0.OR.PERM(IX+1,IZ+1).EQ.0.0.OR.PERM(IX,IZ-1            E2400
     1).EQ.0.0.OR.PERM(IX+1,IZ-1).EQ.0.0) DISP(IX,IZ,3)=0.0                         E2410
      IF (PERM(IX+1,IZ).EQ.0.0.OR.PERM(IX+1,IZ+1).EQ.0.0.OR.PERM(IX-1,IZ            E2420
     1).EQ.0.0.OR.PERM(IX-1,IZ+1).EQ.0.0) DISP(IX,IZ,4)=0.0                         E2430
  240 CONTINUE                                                                      E2440
C     ********************************************************************        E2450
C     ---CHECK FOR STABILITY OF EXPLICIT METHOD---                                E2460
      TIMDIS=0.0                                                                    E2470
      DO 250 IX=2,NNX                                                               E2480
      DO 250 IZ=2,NNZ                                                               E2490
      TDCO=DISP(IX,IZ,1)+DISP(IX,IZ,2)                                              E2500
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  250 IF (TDCO.GT.TIMDIS) TIMDIS=TDCO                                    E2510
      TIMDC=0.5/TIMDIS                                                   E2520
      WRITE (6,520) TIMDC                                                E2530
      NTIMD=TIM(N)/TIMDC                                                 E2540
      NDISP=NTIMD+1                                                      E2550
      IF (NDISP.LE.NMOV) GO TO 260                                       E2560
      NMOV=NDISP                                                         E2570
      TIMV=TIM(N)/NMOV                                                   E2580
      LIM=0                                                              E2590
  260 IF ((TIM(N)-SUMTCH).LT.TIMV) TIMV=TIM(N)-SUMTCH                    E2600
      WRITE (6,510) TIMV,NTIMD,NMOV                                      E2610
C     ******************************************************************E2620
  270 IF (NMOV.EQ.1) GO TO 310                                           E2630
      IF (LIM) 280,290,300                                               E2640
  280 WRITE (6,610)                                                      E2650
      GO TO 320                                                          E2660
  290 WRITE (6,620)                                                      E2670
      GO TO 320                                                          E2680
  300 WRITE (6,630)                                                      E2690
      WRITE (6,640) MAXX,MAXZ                                            E2700
      GO TO 320                                                          E2710
  310 WRITE (6,660)                                                      E2720
C     ******************************************************************E2730
C     ---PRINT DISPERSION EQUATION COEFFICIENTS---                       E2740
  320 IF (NPNTD.EQ.0) GO TO 380                                          E2750
      IF (NPNTD.EQ.2) GO TO 330                                          E2760
      IF (NPNTD.EQ.1.AND.N.EQ.1.AND.IMOV.EQ.0) GO TO 330                 E2770
      GO TO 380                                                          E2780
  330 WRITE (6,530)                                                      E2790
      WRITE (6,540)                                                      E2800
      DO 340 IZ=1,NZ                                                     E2810
  340 WRITE (6,580) (DISP(IX,IZ,1),IX=1,NX)                              E2820
      WRITE (6,550)                                                      E2830
      DO 350 IZ=1,NZ                                                     E2840
  350 WRITE (6,580) (DISP(IX,IZ,2),IX=1,NX)                              E2850
      WRITE (6,560)                                                      E2860
      DO 360 IZ=1,NZ                                                     E2870
  360 WRITE (6,580) (DISP(IX,IZ,3),IX=1,NX)                              E2880
      WRITE (6,570)                                                      E2890
      DO 370 IZ=1,NZ                                                     E2900
  370 WRITE (6,580) (DISP(IX,IZ,4),IX=1,NX)                              E2910
C     ******************************************************************E2920
  380 RETURN                                                             E2930
C     ******************************************************************E2940
C                                                                        E2950
C                                                                        E2960
C                                                                        E2970
  390 FORMAT (1H ,19H TMV (MAX. INJ.) = ,G12.5/20H  TIMV (CELDIS)    = ,G E2980
     112.5)                                                              E2990
  400 FORMAT (1H1,12HX VELOCITIES)                                       E3000
  410 FORMAT (1H ,25X,8HAT NODES/)                                       E3010
  420 FORMAT (1HO,25X,13HON BOUNDARIES/)                                 E3020
  430 FORMAT (1H ,10G12.3)                                               E3030
  440 FORMAT (1H1,12HZ VELOCITIES)                                       E3040
  450 FORMAT (3H   ,11HTIM (N)  = ,1G12.5)                               E3050
  460 FORMAT (3H   ,11HTIMEVELO = ,1G12.5)                               E3060
  470 FORMAT (1H1,10X,29HSTABILITY CRITERIA --- M.O.C.//)                 E3070
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  480 FORMAT (1H0,8H VMAX = ,1PE9.2,5X,7HVMAZ = ,1PE9.2)                    E3080
  490 FORMAT (1H ,8H VMXBD= ,1PE9.2,5X,7HVMZBD= ,1PE9.2)                   E3090
  500 FORMAT (1H0,8H TIMV = ,1PE9.2,5X,8HNTIMV = ,I5,5X,7HNMOV = ,I5/)     E3100
  510 FORMAT (1H0,8H TIMV = ,1PE9.2,5X,8HNTIMD = ,I5,5X,7HNMOV = ,I5)      E3110
  520 FORMAT (3H    ,11HTIMEDISP = ,1E12.5)                                E3120
  530 FORMAT (1H1,32HDISPERSION EQUATION COEFFICIENTS,10X,25H=(D-IJ)*(B)   E3130
     1/(GRID FACTOR))                                                      E3140
  540 FORMAT (1H ,35X,14HXX COEFFICIENT/)                                  E3150
  550 FORMAT (1H ,35X,14HZZ COEFFICIENT/)                                  E3160
  560 FORMAT (1H ,35X,14HXZ COEFFICIENT/)                                  E3170
  570 FORMAT (1H ,35X,14HZX COEFFICIENT/)                                  E3180
  580 FORMAT (1H ,1P10E8.1)                                                E3190
  590 FORMAT (2I4,2F10.1,2F10.7)                                           E3200
  600 FORMAT (8F10.7)                                                      E3210
  610 FORMAT (1H0,10X,42HTHE LIMITING STABILITY CRITERION IS CELDIS)       E3220
  620 FORMAT (1H0,10X,40HTHE LIMITING STABILITY CRITERION IS BETA)         E3230
  630 FORMAT (1H0,10X,58HTHE LIMITING STABILITY CRITERION IS MAXIMUM INJ   E3240
     1ECTION RATE)                                                         E3250
  640 FORMAT (1H ,15X,35HMAX. INJECTION OCCURS AT CELL IX = ,I3,7H  IZ =   E3260
     1 ,I3)                                                                E3270
  650 FORMAT (1H0,5X,47H*** WARNING ***  DECREASE CRITERIA IN E 230-260)   E3280
  660 FORMAT (1H0,10X,63H*TIME INCREMENT FOR SOLUTE TRANSPORT EQUALS TIM   E3290
     1E STEP FOR FLOW*)                                                    E3300
  680 FORMAT (1H ,17HWEIGHTING FACTORS)                                    E3310
  690 FORMAT (1H ,20F5.2)                                                  E3320
      END                                                                  E3330-
      SUBROUTINE MVPT                                                      F  10
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                  F  20
      INTEGER *2PTID                                                       F  30
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO   F  40
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTMV,NPNTVL,NPNTD,N   F  50
     2PNCHV,NPDELC,ICHK,NCONST                                             F  60
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500),   F  70
     1IXOBS(5),IZOBS(5)                                                    F  80
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24   F  90
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR   F 100
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),AOPT(20),TITLE(10),ANFCTR,X   F 110
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL      F 120
      COMMON /XINV/ DXINV,DZINV,ARINV,PORINV                               F 130
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24,   F 140
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5,   F 150
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C   F 160
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI   F 170
     4S,DLTRAT,CSTORM,CSTORT,DMOLEC                                        F 180
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VZBDY(24,20),SUMTDS(24,20),   F 190
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)         F 200
      COMMON /CHMP/ PTID(6400)                                             F 210
C     ***********************************************************************  F 220
      WRITE (6,970) NMOV                                                   F 230
      SUMTCH=SUMT-TIM(N)                                                   F 240
      F1=0.30                                                              F 250
      F2=1.0/3.0                                                           F 260
      IF (NPTPND.EQ.4) F1=0.25                                             F 270
      IF (NPTPND.EQ.9) F1=F2                                               F 280
      IF (NPTPND.EQ.8) F2=0.25                                             F 290
      IF (NPTPND.EQ.16) F1=0.25                                            F 300
      IF (NPTPND.EQ.16) F2=0.125                                           F 310
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```
C      ---MOVE PARTICLES 'NMOV' TIMES---                                F 320
       IMOV=0                                                           F 330
   10  IMOV=IMOV+1                                                      F 340
       CONST1=TIMV*DXINV                                                F 350
       CONST2=TIMV*DZINV                                                F 360
   20  NPTM=NP                                                          F 370
C         ---MOVE EACH PARTICLE---                                      F 380
       DO 880 IN=1,NP                                                   F 390
       IF (PART(1,IN).EQ.0.0) GO TO 880                                 F 400
C      ******************************************************************F 410
C            ---COMPUTE OLD LOCATION---                                 F 420
       XOLD=PART(1,IN)                                                  F 430
       IX=XOLD+0.5                                                      F 440
       IFLAG=1                                                          F 450
       IF (PART(2,IN).GE.0.0) GO TO 30                                  F 460
       IFLAG=-1                                                         F 470
       PART(2,IN)=-PART(2,IN)                                           F 480
   30  ZOLD=PART(2,IN)                                                  F 490
       IZ=ZOLD+0.5                                                      F 500
       IF (PERM(IX,IZ).EQ.0.0) GO TO 880                                F 510
C      ******************************************************************F 520
C            ---COMPUTE NEW LOCATION AND LOCATE CLOSEST NODE---         F 530
C            ---LOCATE NORTHWEST CORNER---                              F 540
       IVX=XOLD                                                         F 550
       IVZ=ZOLD                                                         F 560
       IXE=IVX+1                                                        F 570
       IZS=IVZ+1                                                        F 580
C      ******************************************************************F 590
C         ---LOCATE QUADRANT, VEL. AT 4 CORNERS, CHECK FOR BOUNDARIES---F 600
       CELDX=XOLD-IX                                                    F 610
       CELDZ=ZOLD-IZ                                                    F 620
       ICD=9                                                            F 630
       IF (CELDX.EQ.0.0.AND.CELDZ.EQ.0.0) GO TO 450                     F 640
       IF (CELDX.GE.0.0.OR.CELDZ.GE.0.0) GO TO 70                       F 650
C               ---PT. IN NW QUADRANT---                               F 660
       VXNW=VXBDY(IVX,IVZ)                                              F 670
       VXNE=VX(IXE,IVZ)                                                 F 680
       VXSW=VXBDY(IVX,IZS)                                              F 690
       VXSE=VX(IXE,IZS)                                                 F 700
       VZNW=VZBDY(IVX,IVZ)                                              F 710
       VZNE=VZBDY(IXE,IVZ)                                              F 720
       VZSW=VZ(IVX,IZS)                                                 F 730
       VZSE=VZ(IXE,IZS)                                                 F 740
       ICD=1                                                            F 750
       IF (PERM(IVX,IVZ).EQ.0.0) GO TO 50                               F 760
       IF (PTQ(IXE,IVZ).EQ.0.0) GO TO 40                                F 770
       VXNE=VXNW                                                        F 780
   40  IF (PTQ(IVX,IZS).EQ.0.0) GO TO 50                                F 790
       VZSW=VZNW                                                        F 800
   50  IF (PTQ(IXE,IZS).EQ.0.0) GO TO 270                               F 810
       IF (PERM(IVX,IZS).EQ.0.0) GO TO 60                               F 820
       IF (PERM(IXE+1,IZS).GT.0.0) VXSE=VXSW                            F 830
   60  IF (PERM(IXE,IVZ).EQ.0.0) GO TO 270                              F 840
       IF (PERM(IXE,IZS+1).GT.0.0) VZSE=VZNE                            F 850
       GO TO 270                                                        F 860
C                                                                       F 870
   70  IF (CELDX.LE.0.0.OR.CELDZ.GE.0.0) GO TO 130                      F 880
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C                ---PT. IN NE QUADRANT---
   80 VXNW=VX(IVX,IVZ)                                                  F 890
      VXNE=VXBDY(IVX,IVZ)                                               F 900
      VXSW=VX(IVX,IZS)                                                  F 910
      VXSE=VXBDY(IVX,IZS)                                               F 920
      VZNW=VZBDY(IVX,IVZ)                                               F 930
      VZNE=VZBDY(IXE,IVZ)                                               F 940
      VZSW=VZ(IVX,IZS)                                                  F 950
      VZSE=VZ(IXE,IZS)                                                  F 960
      ICD=2                                                             F 970
      IF (CELDX.EQ.0.0) GO TO 120                                       F 980
      IF (PERM(IXE,IVZ).EQ.0.0) GO TO 100                               F 990
      IF (PTQ(IXE,IZS).EQ.0.0) GO TO 90                                 F1000
      VXNW=VXNE                                                         F1010
   90 IF (PTQ(IXE,IZS).EQ.0.0) GO TO 100                                F1020
      VZSE=VZNE                                                         F1030
  100 IF (PTQ(IVX,IZS).EQ.0.0) GO TO 270                                F1040
      IF (PERM(IXE,IZS).EQ.0.0) GO TO 110                               F1050
      IF (PERM(IVX-1,IZS).GT.0.0) VXSW=VXSE                             F1060
  110 IF (PERM(IVX,IVZ).EQ.0.0) GO TO 270                               F1070
      IF (PERM(IVX,IZS+1).GT.0.0) VZSW=VZNW                             F1080
      GO TO 270                                                         F1090
  120 IF (PTQ(IVX,IZS).EQ.0.0) GO TO 270                                F1100
      IF (PERM(IVX,IVZ).EQ.0.0) GO TO 270                               F1110
      IF (PERM(IVX,IZS+1).GT.0.0) VZSW=VZNW                             F1120
      GO TO 270                                                         F1130
C                                                                       F1140
  130 IF (CELDZ.LE.0.0.OR.CELDX.GE.0.0) GO TO 190                       F1150
C                ---PT. IN SW QUADRANT---                               F1160
  140 VXNW=VXBDY(IVX,IVZ)                                               F1170
      VXNE=VX(IXE,IVZ)                                                  F1180
      VXSW=VXBDY(IVX,IZS)                                               F1190
      VXSE=VX(IXE,IZS)                                                  F1200
      VZNW=VZ(IVX,IVZ)                                                  F1210
      VZNE=VZ(IXE,IVZ)                                                  F1220
      VZSW=VZBDY(IVX,IVZ)                                               F1230
      VZSE=VZBDY(IXE,IVZ)                                               F1240
      ICD=3                                                             F1250
      IF (CELDZ.EQ.0.0) GO TO 180                                       F1260
      IF (PERM(IVX,IZS).EQ.0.0) GO TO 160                               F1270
      IF (PTQ(IVX,IVZ).EQ.0.0) GO TO 150                                F1280
      VZNW=VZSW                                                         F1290
  150 IF (PTQ(IXE,IZS).EQ.0.0) GO TO 160                                F1300
      VXSE=VXSW                                                         F1310
  160 IF (PTQ(IXE,IVZ).EQ.0.0) GO TO 270                                F1320
      IF (PERM(IVX,IVZ).EQ.0.0) GO TO 170                               F1330
      IF (PERM(IXE+1,IVZ).GT.0.0) VXNE=VXNW                             F1340
  170 IF (PERM(IXE,IZS).EQ.0.0) GO TO 270                               F1350
      IF (PERM(IXE,IVZ-1).GT.0.0) VZNE=VZSE                             F1360
      GO TO 270                                                         F1370
  180 IF (PTQ(IXE,IVZ).EQ.0.0) GO TO 270                                F1380
      IF (PERM(IVX,IVZ).EQ.0.0) GO TO 270                               F1390
      IF (PERM(IXE+1,IVZ).GT.0.0) VXNE=VXNW                             F1400
      GO TO 270                                                         F1410
C                                                                       F1420
  190 IF (CELDZ.LE.0.0.OR.CELDX.LE.0.0) GO TO 260                       F1430
C                ---PT. IN SE QUADRANT---                               F1440
                                                                        F1450
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  200 VXNW=VX(IVX,IVZ)                                                  F1460
      VXNE=VXBDY(IVX,IVZ)                                               F1470
      VXSW=VX(IVX,IZS)                                                  F1480
      VXSE=VXBDY(IVX,IZS)                                               F1490
      VZNW=VZ(IVX,IVZ)                                                  F1500
      VZNE=VZ(IXE,IVZ)                                                  F1510
      VZSW=VZBDY(IVX,IVZ)                                               F1520
      VZSE=VZBDY(IXE,IVZ)                                               F1530
      ICD=4                                                             F1540
      IF (CELDZ.EQ.0.0) GO TO 240                                       F1550
      IF (CELDX.EQ.0.0) GO TO 250                                       F1560
      IF (PERM(IXE,IZS).EQ.0.0) GO TO 220                               F1570
      IF (PTQ(IXE,IVZ).EQ.0.0) GO TO 210                                F1580
      VZNE=VZSE                                                         F1590
  210 IF (PTQ(IVX,IZS).EQ.0.0) GO TO 220                                F1600
      VXSW=VXSE                                                         F1610
  220 IF (PTQ(IVX,IVZ).EQ.0.0) GO TO 270                                F1620
      IF (PERM(IXE,IVZ).EQ.0.0) GO TO 230                               F1630
      IF (PERM(IVX-1,IVZ).GT.0.0) VXNW=VXNE                             F1640
  230 IF (PERM(IVX,IZS).EQ.0.0) GO TO 270                               F1650
      IF (PERM(IVX,IVZ-1).GT.0.0) VZNW=VZSW                             F1660
      GO TO 270                                                         F1670
  240 IF (PTQ(IVX,IVZ).EQ.0.0) GO TO 270                                F1680
      IF (PERM(IXE,IVZ).EQ.0.0) GO TO 270                               F1690
      IF (PERM(IVX-1,IVZ).GT.0.0) VXNW=VXNE                             F1700
      GO TO 270                                                         F1710
  250 IF (PTQ(IVX,IVZ).EQ.0.0) GO TO 270                                F1720
      IF (PERM(IVX,IZS).EQ.0.0) GO TO 270                               F1730
      IF (PERM(IVX,IVZ-1).GT.0.0) VZNW=VZSW                             F1740
      GO TO 270                                                         F1750
C                                                                       F1760
  260 IF (CELDX.EQ.0.0.AND.CELDZ.LT.0.0) GO TO 80                       F1770
      IF (CELDX.LT.0.0.AND.CELDZ.EQ.0.0) GO TO 140                      F1780
      IF (CELDX.GT.0.0.AND.CELDZ.EQ.0.0) GO TO 200                      F1790
      IF (CELDX.EQ.0.0.AND.CELDZ.GT.0.0) GO TO 200                      F1800
      WRITE (6,980) IN,IX,IZ                                            F1810
  270 CONTINUE                                                          F1820
C              --- CHECK FOR ADJACENT NO-FLOW BOUNDARIES---            F1830
      GO TO (280,320,360,400,440), ICD                                  F1840
      GO TO 440                                                         F1850
  280 IF (PERM(IXE,IVZ).EQ.0.0) GO TO 290                               F1860
      IF (PERM(IVX,IZS).EQ.0.0) GO TO 300                               F1870
      IF (PERM(IVX,IVZ).EQ.0.0) GO TO 310                               F1880
      GO TO 440                                                         F1890
  290 VXNE=VXSE                                                         F1900
      IF (PERM(IVX,IZS).GT.0.0) GO TO 310                               F1910
  300 VZSW=VZSE                                                         F1920
  310 VXNW=VXSW                                                         F1930
      VZNW=VZNE                                                         F1940
      GO TO 440                                                         F1950
  320 IF (PERM(IVX,IVZ).EQ.0.0) GO TO 330                               F1960
      IF (PERM(IXE,IZS).EQ.0.0) GO TO 340                               F1970
      IF (PERM(IXE,IVZ).EQ.0.0) GO TO 350                               F1980
      GO TO 440                                                         F1990
  330 VXNW=VXSW                                                         F2000
      IF (PERM(IXE,IZS).GT.0.0) GO TO 350                               F2010
  340 VZSE=VZSW                                                         F2020
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      GO TO 480                                                          F2600
  470 BEYON=TEMPX-IX                                                     F2610
      IF (BEYON.LT.0.0) BEYON=BEYON+0.5                                  F2620
      IF (BEYON.GT.0.0) BEYON=BEYON-0.5                                  F2630
      PART(1,IN)=TEMPX-2.0*BEYON                                         F2640
      INX=PART(1,IN)+0.5                                                 F2650
      TEMPX=PART(1,IN)                                                   F2660
C     ********************************************************************F2670
C           ---Z BOUNDARY---                                             F2680
  480 IF (PERM(INX,INZ).EQ.0.0) GO TO 490                                F2690
      PART(2,IN)=TEMPZ                                                   F2700
      GO TO 510                                                          F2710
C     ********************************************************************F2720
  490 BEYON=TEMPZ-IZ                                                     F2730
      IF (BEYON.LT.0.0) BEYON=BEYON+0.5                                  F2740
      IF (BEYON.GT.0.0) BEYON=BEYON-0.5                                  F2750
      PART(2,IN)=TEMPZ-2.0*BEYON                                         F2760
      INZ=PART(2,IN)+0.5                                                 F2770
      TEMPZ=PART(2,IN)                                                   F2780
      GO TO 510                                                          F2790
  500 PART(1,IN)=TEMPX                                                   F2800
      PART(2,IN)=TEMPZ                                                   F2810
  510 CONTINUE                                                           F2820
C     ********************************************************************F2830
C        ---SUM CONCENTRATIONS AND COUNT PARTICLES---                    F2840
      SUMC(INX,INZ)=SUMC(INX,INZ)+PART(4,IN)*PTWT(IN)                    F2850
      SUMTDS(INX,INZ)=SUMTDS(INX,INZ)+PART(3,IN)*PTWT(IN)                F2860
      NPCELL(INX,INZ)=NPCELL(INX,INZ)+1                                  F2870
      SUMWT(INX,INZ)=SUMWT(INX,INZ)+PTWT(IN)                             F2880
C     ********************************************************************F2890
C        ---CHECK FOR CHANGE IN CELL LOCATION---                         F2900
      IF (IX.EQ.INX.AND.IZ.EQ.INZ) GO TO 870                             F2910
C           ---CHECK FOR CONST.-HEAD BDY. OR SOURCE AT OLD LOCATION---   F2920
      IF (PTQ(IX,IZ).LT.0.0) GO TO 520                                   F2930
      GO TO 830                                                          F2940
C     ********************************************************************F2950
C           ---CREATE NEW PARTICLES AT BOUNDARIES---                     F2960
  520 IF (IFLAG.GT.0) GO TO 840                                          F2970
      DO 530 IL=1,500                                                    F2980
      IF (LIMBO(IL).EQ.0) GO TO 530                                      F2990
      IP=LIMBO(IL)                                                       F3000
      IF (IP.LT.IN) GO TO 540                                            F3010
  530 CONTINUE                                                           F3020
C     ********************************************************************F3030
C           ---GENERATE NEW PARTICLE---                                  F3040
      IF (NPTM.EQ.NPMAX) GO TO 890                                       F3050
      NPTM=NPTM+1                                                        F3060
      IP=NPTM                                                            F3070
      GO TO 550                                                          F3080
  540 LIMBO(IL)=0                                                        F3090
  550 ITEM=PTID(IN)                                                      F3100
      IF (NPTPND.EQ.16) GO TO 560                                        F3110
      GO TO (570,580,590,600,610,620,630,640,650), ITEM                  F3120
      GO TO 610                                                          F3130
  560 GO TO (660,670,680,690,700,710,720,730,740,750,760,770,780,790,800 F3140
     1,810), ITEM                                                        F3150
      GO TO 610                                                          F3160
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  570 PART(1,IP)=IX-F1                                                  F3170
      PART(2,IP)=IZ-F1                                                  F3180
      PTID(IP)=1                                                        F3190
      GO TO 820                                                         F3200
  580 PART(1,IP)=IX-F1                                                  F3210
      PART(2,IP)=IZ+F1                                                  F3220
      PTID(IP)=2                                                        F3230
      GO TO 820                                                         F3240
  590 PART(1,IP)=IX+F1                                                  F3250
      PART(2,IP)=IZ-F1                                                  F3260
      PTID(IP)=3                                                        F3270
      GO TO 820                                                         F3280
  600 PART(1,IP)=IX+F1                                                  F3290
      PART(2,IP)=IZ+F1                                                  F3300
      PTID(IP)=4                                                        F3310
      GO TO 820                                                         F3320
  610 PART(1,IP)=IX                                                     F3330
      PART(2,IP)=IZ                                                     F3340
      PTID(IP)=5                                                        F3350
      GO TO 820                                                         F3360
  620 PART(1,IP)=IX-F2                                                  F3370
      PART(2,IP)=IZ                                                     F3380
      PTID(IP)=6                                                        F3390
      GO TO 820                                                         F3400
  630 PART(1,IP)=IX                                                     F3410
      PART(2,IP)=IZ-F2                                                  F3420
      PTID(IP)=7                                                        F3430
      GO TO 820                                                         F3440
  640 PART(1,IP)=IX+F2                                                  F3450
      PART(2,IP)=IZ                                                     F3460
      PTID(IP)=8                                                        F3470
      GO TO 820                                                         F3480
  650 PART(1,IP)=IX                                                     F3490
      PART(2,IP)=IZ+F2                                                  F3500
      PTID(IP)=9                                                        F3510
      GO TO 820                                                         F3520
  660 PART(1,IP)=IX-F1-F2                                               F3530
      PART(2,IP)=IZ-F1-F2                                               F3540
      PTID(IP)=1                                                        F3550
      GO TO 820                                                         F3560
  670 PART(1,IP)=IX-F1-F2                                               F3570
      PART(2,IP)=IZ-F1+F2                                               F3580
      PTID(IP)=2                                                        F3590
      GO TO 820                                                         F3600
  680 PART(1,IP)=IX-F1+F2                                               F3610
      PART(2,IP)=IZ-F1-F2                                               F3620
      PTID(IP)=3                                                        F3630
      GO TO 820                                                         F3640
  690 PART(1,IP)=IX-F1+F2                                               F3650
      PART(2,IP)=IZ-F1+F2                                               F3660
      PTID(IP)=4                                                        F3670
      GO TO 820                                                         F3680
  700 PART(1,IP)=IX-F1-F2                                               F3690
      PART(2,IP)=IZ+F1-F2                                               F3700
      PTID(IP)=5                                                        F3710
      GO TO 820                                                         F3720
  710 PART(1,IP)=IX-F1-F2                                               F3730
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      PART(2,IP)=IZ+F1+F2                                                F3740
      PTID(IP)=6                                                         F3750
      GO TO 820                                                          F3760
  720 PART(1,IP)=IX-F1+F2                                                F3770
      PART(2,IP)=IZ+F1-F2                                                F3780
      PTID(IP)=7                                                         F3790
      GO TO 820                                                          F3800
  730 PART(1,IP)=IX-F1+F2                                                F3810
      PART(2,IP)=IZ+F1+F2                                                F3820
      PTID(IP)=8                                                         F3830
      GO TO 820                                                          F3840
  740 PART(1,IP)=IX+F1-F2                                                F3850
      PART(2,IP)=IZ-F1-F2                                                F3860
      PTID(IP)=9                                                         F3870
      GO TO 820                                                          F3880
  750 PART(1,IP)=IX+F1-F2                                                F3890
      PART(2,IP)=IZ-F1+F2                                                F3900
      PTID(IP)=10                                                        F3910
      GO TO 820                                                          F3920
  760 PART(1,IP)=IX+F1+F2                                                F3930
      PART(2,IP)=IZ-F1-F2                                                F3940
      PTID(IP)=11                                                        F3950
      GO TO 820                                                          F3960
  770 PART(1,IP)=IX+F1+F2                                                F3970
      PART(2,IP)=IZ-F1+F2                                                F3980
      PTID(IP)=12                                                        F3990
      GO TO 820                                                          F4000
  780 PART(1,IP)=IX+F1-F2                                                F4010
      PART(2,IP)=IZ+F1-F2                                                F4020
      PTID(IP)=13                                                        F4030
      GO TO 820                                                          F4040
  790 PART(1,IP)=IX+F1-F2                                                F4050
      PART(2,IP)=IZ+F1+F2                                                F4060
      PTID(IP)=14                                                        F4070
      GO TO 820                                                          F4080
  800 PART(1,IP)=IX+F1+F2                                                F4090
      PART(2,IP)=IZ+F1-F2                                                F4100
      PTID(IP)=15                                                        F4110
      GO TO 820                                                          F4120
  810 PART(1,IP)=IX+F1+F2                                                F4130
      PART(2,IP)=IZ+F1+F2                                                F4140
      PTID(IP)=16                                                        F4150
      GO TO 820                                                          F4160
C                                                                        F4170
  820 PART(2,IP)=-PART(2,IP)                                             F4180
      PART(3,IP)=TDS(IX,IZ)                                              F4190
      PART(4,IP)=CONC(IX,IZ)                                             F4200
      PTWT(IP)=WTFCTR(IX,IZ)                                             F4210
C     ********************************************************************F4220
C           ---CHECK FOR DISCHARGE BOUNDARY AT NEW LOCATION---           F4230
  830 IFLAG=1.0                                                          F4240
  840 IF (PTQ(INX,INZ).GT.0.0) GO TO 850                                 F4250
      GO TO 880                                                          F4260
C     ********************************************************************F4270
C           ---PUT PT. IN LIMBO IF PT. DENSITY NOT INCREASED---          F4280
  850 PTWT(IN)=PTWT(IN)*WTFCTR(INX,INZ)                                  F4290
      IF (PTWT(IN).GT.0.001) GO TO 880                                   F4300
```

```
      PART(1,IN)=0.0                                                    F4310
      PART(2,IN)=0.0                                                    F4320
      PART(3,IN)=0.0                                                    F4330
      PART(4,IN)=0.0                                                    F4340
      DO 860 ID=1,500                                                   F4350
      IF (LIMBO(ID).GT.0) GO TO 860                                     F4360
      LIMBO(ID)=IN                                                      F4370
      GO TO 880                                                         F4380
  860 CONTINUE                                                          F4390
C                                                                       F4400
  870 IF (IFLAG.LT.0) PART(2,IN)=-TEMPZ                                 F4410
  880 CONTINUE                                                          F4420
C     ---END OF LOOP---                                                 F4430
C     ******************************************************************F4440
      GO TO 920                                                         F4450
C        ---RESTART MOVE IF PT. LIMIT EXCEEDED---                       F4460
  890 WRITE (6,990) IMOV,IN                                             F4470
      TEST=100.0                                                        F4480
      WRITE (6,1000)                                                    F4490
      DO 900 IZ=1,NZ                                                    F4500
  900 WRITE (6,1010) (NPCELL(IX,IZ),IX=1,NX)                            F4510
      CALL GENPT                                                        F4520
      DO 910 IX=1,NX                                                    F4530
      DO 910 IZ=1,NZ                                                    F4540
      SUMC(IX,IZ)=0.0                                                   F4550
      SUMTDS(IX,IZ)=0.0                                                 F4560
      SUMWT(IX,IZ)=0.0                                                  F4570
  910 NPCELL(IX,IZ)=0                                                   F4580
      TEST=0.0                                                          F4590
      GO TO 20                                                          F4600
C     ******************************************************************F4610
  920 SUMTCH=SUMTCH+TIMV                                                F4620
C        ---ADJUST NUMBER OF PARTICLES---                               F4630
      NP=NPTM                                                           F4640
      WRITE (6,960) NP,IMOV                                             F4650
C     ******************************************************************F4660
      CALL CNCON                                                        F4670
C     ******************************************************************F4680
C        ---STORE OBS. WELL DATA FOR STEADY FLOW PROBLEMS---            F4690
      IF (S.GT.0.0) GO TO 940                                           F4700
      IF (NUMOBS.LE.0) GO TO 940                                        F4710
      J=MOD(IMOV,50)                                                    F4720
      IF (J.EQ.0) J=50                                                  F4730
      TMOBS(J)=SUMTCH                                                   F4740
      DO 930 I=1,NUMOBS                                                 F4750
      TMWL(I,J)=PK(IXOBS(I),IZOBS(I))                                   F4760
      TMCN(I,J)=CONC(IXOBS(I),IZOBS(I))                                 F4770
  930 TMTDS(I,J)=TDS(IXOBS(I),IZOBS(I))                                 F4780
C        ---PRINT CHEMICAL OUTPUT---                                    F4790
      IF (MOD(IMOV,50).EQ.0) IPRNT=1                                    F4800
  940 IF (MOD(IMOV,NPNTMV).EQ.0) IPRNT=-1                               F4810
      IF (IPRNT.NE.0) CALL CHMOT                                        F4820
      IF (TIMV.LT.0.1) GO TO 950                                        F4830
      IF ((TIM(N)-SUMTCH).LT.TIMV) TIMV=TIM(N)-SUMTCH                   F4840
      GO TO 10                                                          F4850
C     ******************************************************************F4860
  950 RETURN                                                            F4870
```

```
C     ******************************************************************    F4880
C                                                                            F4890
C                                                                            F4900
C                                                                            F4910
  960 FORMAT (1HO,2X,2HNP,7X,2H= ,8X,I4,10X,11HIMOV     = ,8X,I4)           F4920
  970 FORMAT (1HO,10X,61HNO. OF PARTICLE MOVES REQUIRED TO COMPLETE THIS     F4930
     1 TIME STEP  = ,I4//)                                                   F4940
  980 FORMAT (1HO,5X,53H*** WARNING ***     QUADRANT NOT LOCATED FOR PT.     F4950
     1 NO. ,I5,11H , IN CELL ,2I4)                                           F4960
  990 FORMAT (1HO,5X,17H ***   NOTE   ***,10X,23HNPTM.EQ.NPMAX --- IMOV=      F4970
     1,I4,5X,8HPT. NO.=,I4,5X,10HCALL GENPT/)                                F4980
 1000 FORMAT (1HO,2X,6HNPCELL/)                                              F4990
 1010 FORMAT (1H ,4X,24I3)                                                   F5000
      END                                                                    F5010-
      SUBROUTINE CNCON                                                       G  10
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                    G  20
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO     G  30
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTMV,NPNTVL,NPNTD,N     G  40
     2PNCHV,NPDELC,ICHK,NCONST                                               G  50
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500),     G  60
     1IXOBS(5),IZOBS(5)                                                      G  70
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24     G  80
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR     G  90
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),ADPT(20),TITLE(10),ANFCTR,X     G 100
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL        G 110
      COMMON /DENVIS/ DEN1,DEN2,VIS1,VIS2                                    G 120
      COMMON /XINV/ DXINV,DZINV,ARINV,PORINV                                 G 130
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24,     G 140
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5,     G 150
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C     G 160
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI     G 170
     4S,DLTRAT,CSTORM,CSTORT,DMOLEC                                          G 180
      COMMON /DIFUS/ DISP(24,20,4)                                           G 190
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VZBDY(24,20),SUMTDS(24,20),     G 200
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)           G 210
      COMMON /CNCHNG/ CNCHCK(24,20),CTOL                                     G 220
      DIMENSION CNCNC(24,20), CNOLD(24,20), TDSOLD(24,20), CNTDS(24,20)      G 230
C     ******************************************************************     G 240
      ITEST=0                                                                G 250
      DO 10 IX=2,NNX                                                         G 260
      DO 10 IZ=2,NNZ                                                         G 270
      CNOLD(IX,IZ)=CONC(IX,IZ)                                               G 280
      TDSOLD(IX,IZ)=TDS(IX,IZ)                                               G 290
      CNCNC(IX,IZ)=0.0                                                       G 300
   10 CNTDS(IX,IZ)=0.0                                                       G 310
      APC=0.0                                                                G 320
      NZERO=0                                                                G 330
      TVA=AREA*TIMV                                                          G 340
      ARPOR=AREA*POROS                                                       G 350
C     ******************************************************************     G 360
C     ---CONC. CHANGE FOR 0.5*TIMV DUE TO:                                   G 370
C           RECHARGE, LEAKAGE, DIVERGENCE OF VELOCITY...                     G 380
      CONST=0.5*TIMV                                                         G 390
   20 DO 70 IX=2,NNX                                                         G 400
      DO 70 IZ=2,NNZ                                                         G 410
      IF (PERM(IX,IZ).EQ.0.0) GO TO 70                                       G 420
      EQFCT1=CONST                                                           G 430
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      EQFCT2=EQFCT1/POROS
      C1=CONC(IX,IZ)                                                    G 440
      C2=TDS(IX,IZ)                                                     G 450
      IF (ABS(C1).LT.1.0E-20) C1=0.0                                    G 460
      IF (ABS(C2).LT.1.0E-20) C2=0.0                                    G 470
      CLKCN1=0.0                                                        G 480
      CLKCN2=0.0                                                        G 490
      SLEAK=(PK(IX,IZ)-PI(IX,IZ)+DENS(IX,IZ)*ELEV(IX,IZ))               G 500
      SLEAK=SLEAK*VPRM(IX,IZ)/DENS(IX,IZ)                               G 510
      DENSE=DENS(IX,IZ)                                                 G 520
      IF (PI(IX,IZ).GT.PK(IX,IZ)) DENSE=DEN1*TDSREC(IX,IZ)+DEN2         G 530
      IF (SLEAK.GT.0.0) GO TO 30                                        G 540
      CLKCN1=CNREC(IX,IZ)                                               G 550
      CLKCN2=TDSREC(IX,IZ)                                              G 560
      GO TO 40                                                          G 570
   30 CLKCN1=C1                                                         G 580
      CLKCN2=C2                                                         G 590
   40 CNREC1=C1                                                         G 600
      CNREC2=C2                                                         G 610
      DENSE=DENS(IX,IZ)                                                 G 620
      IF (REC(IX,IZ).LT.0.0) DENSE=DEN1*TDSREC(IX,IZ)+DEN2              G 630
      RATE=REC(IX,IZ)/DENSE                                             G 640
      IF (REC(IX,IZ).GT.0.0) GO TO 50                                   G 650
      CNREC1=CNREC(IX,IZ)                                               G 660
      CNREC2=TDSREC(IX,IZ)                                              G 670
   50 DIV1=SLEAK+RATE                                                   G 680
      DIV2=SLEAK+RATE                                                   G 690
      DELC1=EQFCT2*(C1*DIV1-SLEAK*CLKCN1-RATE*CNREC1)                   G 700
      DELC2=EQFCT2*(C2*DIV2-SLEAK*CLKCN2-RATE*CNREC2)                   G 710
      CNCNC(IX,IZ)=CNCNC(IX,IZ)+DELC1                                   G 720
      CNTDS(IX,IZ)=CNTDS(IX,IZ)+DELC2                                   G 730
C     ---CONC. CHANGE DUE TO DISPERSION FOR 0.5*TIMV---                 G 740
C        ---DISPERSION WITH TENSOR COEFFICIENTS---                      G 750
      IF (BETA.EQ.0.0.AND.DMOLEC.EQ.0.0) GO TO 70                       G 760
      IF (NCONST.LT.2) GO TO 60                                         G 770
      X1=DISP(IX,IZ,1)*(CONC(IX+1,IZ)-C1)                               G 780
      X2=DISP(IX-1,IZ,1)*(CONC(IX-1,IZ)-C1)                             G 790
      Z1=DISP(IX,IZ,2)*(CONC(IX,IZ+1)-C1)                               G 800
      Z2=DISP(IX,IZ-1,2)*(CONC(IX,IZ-1)-C1)                             G 810
      XX1=DISP(IX,IZ,3)*(CONC(IX,IZ+1)+CONC(IX+1,IZ+1)-CONC(IX,IZ-1)-CON G 820
     1C(IX+1,IZ-1))                                                     G 830
      XX2=DISP(IX-1,IZ,3)*(CONC(IX,IZ+1)+CONC(IX-1,IZ+1)-CONC(IX,IZ-1)-C G 840
     1ONC(IX-1,IZ-1))                                                   G 850
      ZZ1=DISP(IX,IZ,4)*(CONC(IX+1,IZ)+CONC(IX+1,IZ+1)-CONC(IX-1,IZ)-CON G 860
     1C(IX-1,IZ+1))                                                     G 870
      ZZ2=DISP(IX,IZ-1,4)*(CONC(IX+1,IZ)+CONC(IX+1,IZ-1)-CONC(IX-1,IZ)-C G 880
     1ONC(IX-1,IZ-1))                                                   G 890
      CNCNC(IX,IZ)=CNCNC(IX,IZ)+EQFCT1*(X1+X2+Z1+Z2+XX1-XX2+ZZ1-ZZ2)    G 900
   60 X1=DISP(IX,IZ,1)*(TDS(IX+1,IZ)-C2)                                G 910
      X2=DISP(IX-1,IZ,1)*(TDS(IX-1,IZ)-C2)                              G 920
      Z1=DISP(IX,IZ,2)*(TDS(IX,IZ+1)-C2)                                G 930
      Z2=DISP(IX,IZ-1,2)*(TDS(IX,IZ-1)-C2)                              G 940
      XX1=DISP(IX,IZ,3)*(TDS(IX,IZ+1)+TDS(IX+1,IZ+1)-TDS(IX,IZ-1)-TDS(IX G 950
     1+1,IZ-1))                                                         G 960
      XX2=DISP(IX-1,IZ,3)*(TDS(IX,IZ+1)+TDS(IX-1,IZ+1)-TDS(IX,IZ-1)-TDS( G 970
     1IX-1,IZ-1))                                                       G 980
      ZZ1=DISP(IX,IZ,4)*(TDS(IX+1,IZ)+TDS(IX+1,IZ+1)-TDS(IX-1,IZ)-TDS(IX G 990
                                                                        G1000
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     1-1,IZ+1))                                                                 G1010
      ZZ2=DISP(IX,IZ-1,4)*(TDS(IX+1,IZ)+TDS(IX+1,IZ-1)-TDS(IX-1,IZ)-TDS(       G1020
     1IX-1,IZ-1))                                                               G1030
      CNTDS(IX,IZ)=CNTDS(IX,IZ)+EQFCT1*(X1+X2+Z1+Z2+XX1-XX2+ZZ1-ZZ2)           G1040
   70 CONTINUE                                                                  G1050
C     ******************************************************************       G1060
      ITEST=ITEST+1                                                             G1070
      IF (ITEST.EQ.1) GO TO 80                                                  G1080
      GO TO 120                                                                 G1090
C     ******************************************************************       G1100
C     ---CONC. CHANGE AT NODES DUE TO CONVECTION---                             G1110
   80 DO 100 IX=2,NNX                                                           G1120
      DO 100 IZ=2,NNZ                                                           G1130
      IF (PERM(IX,IZ).EQ.0.0) GO TO 100                                         G1140
      APC=NPCELL(IX,IZ)                                                         G1150
      IF (APC.GT.0.0) GO TO 90                                                  G1160
      IF (PTQ(IX,IZ).NE.0.0) GO TO 100                                          G1170
      NZERO=NZERO+1                                                             G1180
      GO TO 100                                                                 G1190
   90 CONC(IX,IZ)=SUMC(IX,IZ)/SUMWT(IX,IZ)                                      G1200
      TDS(IX,IZ)=SUMTDS(IX,IZ)/SUMWT(IX,IZ)                                     G1210
  100 CONTINUE                                                                  G1220
C        ---CHECK NUMBER OF CELLS VOID OF PTS.---                               G1230
      IF (NZERO.GT.0) WRITE (6,330) NZERO,IMOV                                  G1240
      IF (NZERO.LE.NZCRIT) GO TO 20                                             G1250
      TEST=99.0                                                                 G1260
      WRITE (6,340)                                                             G1270
      WRITE (6,360)                                                             G1280
      DO 110 IZ=1,NZ                                                            G1290
  110 WRITE (6,370) (NPCELL(IX,IZ),IX=1,NX)                                     G1300
      GO TO 20                                                                  G1310
C     ******************************************************************       G1320
C     ---CHANGE CONCENTRATIONS AT NODES---                                      G1330
  120 DO 150 IX=2,NNX                                                           G1340
      DO 150 IZ=2,NNZ                                                           G1350
      IF (PERM(IX,IZ).EQ.0.0) GO TO 140                                         G1360
      CNCPCT=0.0                                                                G1370
      TDSPCT=0.0                                                                G1380
      IF (CONC(IX,IZ).GT.0.0) CNCPCT=CNCNC(IX,IZ)/CONC(IX,IZ)                   G1390
      IF (TDS(IX,IZ).GT.0.0)  TDSPCT=CNTDS(IX,IZ)/TDS(IX,IZ)                    G1400
      CONC(IX,IZ)=CONC(IX,IZ)+CNCNC(IX,IZ)                                      G1410
      TDS(IX,IZ)=TDS(IX,IZ)+CNTDS(IX,IZ)                                        G1420
      SUMC(IX,IZ)=0.0                                                           G1430
      SUMTDS(IX,IZ)=0.0                                                         G1440
      IF (CNCPCT.LT.0.0) SUMC(IX,IZ)=CNCPCT                                     G1450
      IF (TDSPCT.LT.0.0) SUMTDS(IX,IZ)=TDSPCT                                   G1460
      GO TO 150                                                                 G1470
  140 IF (CONC(IX,IZ).GT.0.0) WRITE (6,350) IX,IZ,CONC(IX,IZ)                   G1480
      CONC(IX,IZ)=0.0                                                           G1490
  150 CONTINUE                                                                  G1500
C     ******************************************************************       G1510
C     ---CHANGE CONCENTRATION OF PARTICLES---                                   G1520
      DO 220 IN=1,NP                                                            G1530
      IF (PART(1,IN).EQ.0.0) GO TO 220                                          G1540
      INX=ABS(PART(1,IN))+0.5                                                   G1550
      INZ=ABS(PART(2,IN))+0.5                                                   G1560
C     ---UPDATE CONC. OF PTS. IN SINK/SOURCE CELLS---                           G1570
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      IF (PTQ(INX,INZ).EQ.0.0) GO TO 160                                    G1580
      PART(4,IN)=CONC(INX,INZ)                                              G1590
      PART(3,IN)=TDS(INX,INZ)                                               G1600
      GO TO 220                                                             G1610
  160 IF (CNCNC(INX,INZ).LT.0.0) GO TO 180                                  G1620
  170 PART(4,IN)=PART(4,IN)+CNCNC(INX,INZ)                                  G1630
      GO TO 190                                                             G1640
  180 IF (CONC(INX,INZ).LE.0.0) GO TO 170                                   G1650
      IF (SUMC(INX,INZ).LT.-1.0) GO TO 170                                  G1660
      PART(4,IN)=PART(4,IN)+PART(4,IN)*SUMC(INX,INZ)                        G1670
  190 IF (CNTDS(INX,INZ).LT.0.0) GO TO 210                                  G1680
  200 PART(3,IN)=PART(3,IN)+CNTDS(INX,INZ)                                  G1690
      GO TO 220                                                             G1700
  210 IF (TDS(INX,INZ).LE.0.0) GO TO 200                                    G1710
      IF (SUMTDS(INX,INZ).LT.-1.0) GO TO 200                                G1720
      PART(3,IN)=PART(3,IN)+PART(3,IN)*SUMTDS(INX,INZ)                      G1730
  220 CONTINUE                                                              G1740
      WRITE (6,320) TIM(N),TIMV,SUMTCH                                      G1750
C     ********************************************************************* G1760
C     ---COMPUTE MASS BALANCE FOR SOLUTE---                                 G1770
      CSTORM=0.0                                                            G1780
      STORM=0.0                                                             G1790
      CSTORT=0.0                                                            G1800
      STORT=0.0                                                             G1810
      DO 290 IX=2,NNX                                                       G1820
      DO 290 IZ=2,NNZ                                                       G1830
      IF (PERM(IX,IZ).EQ.0.0) GO TO 290                                     G1840
      SUMC(IX,IZ)=0.0                                                       G1850
      SUMWT(IX,IZ)=0.0                                                      G1860
      SUMTDS(IX,IZ)=0.0                                                     G1870
      WTFCT=0.0                                                             G1880
C        ---COMPUTE MASS OF SOLUTE IN STORAGE---                            G1890
      STORM=STORM+CONC(IX,IZ)*WIDTH*ARPOR                                   G1900
      STORT=STORT+TDS(IX,IZ)*WIDTH*ARPOR                                    G1910
C        ---ACCOUNT FOR MASS PUMPED IN, OUT, RECHARGED, & DISCHARGED---     G1920
      IF (REC(IX,IZ)) 240,250,230                                           G1930
  230 RATE=REC(IX,IZ)*VOL/DENS(IX,IZ)                                       G1940
      TDSOUT=TDSOUT+(RATE*TIMV*0.5*(TDSOLD(IX,IZ)+TDS(IX,IZ)))              G1950
      CMSOUT=CMSOUT+(RATE*TIMV*0.5*(CNOLD(IX,IZ)+CONC(IX,IZ)))              G1960
      GO TO 250                                                             G1970
  240 DENSE=DEN1*TDSREC(IX,IZ)+DEN2                                         G1980
      RATE=REC(IX,IZ)*VOL/DENSE                                             G1990
      TDSIN=TDSIN+RATE*TDSREC(IX,IZ)*TIMV                                   G2000
      CMSIN=CMSIN+RATE*CNREC(IX,IZ)*TIMV                                    G2010
C     ********************************************************************* G2020
C        ---ACCOUNT FOR BOUNDARY FLOW---                                    G2030
  250 IF (VPRM(IX,IZ).EQ.0.0) GO TO 280                                     G2040
      FLW=VPRM(IX,IZ)*(PI(IX,IZ)-PK(IX,IZ)+DENS(IX,IZ)*ELEV(IX,IZ))        G2050
      FLW=FLW/DENS(IX,IZ)                                                   G2060
      IF (FLW.GT.0.0) GO TO 260                                             G2070
      IF (FLW.LT.0.0) GO TO 270                                             G2080
      GO TO 280                                                             G2090
C           ---MASS IN BOUNDARY DURING TIME STEP---                         G2100
  260 FLMIN=FLMIN+FLW*CNREC(IX,IZ)*TVA*WIDTH                                G2110
      FLTIN=FLTIN+FLW*TDSREC(IX,IZ)*TVA*WIDTH                               G2120
      GO TO 280                                                             G2130
C           ---MASS OUT DURING TIME STEP---                                 G2140
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  270 FLMOT=FLMOT+FLW*TVA*WIDTH*0.5*(CNOLD(IX,IZ)+CONC(IX,IZ))                G2150
      FLTOT=FLTOT+FLW*TVA*WIDTH*0.5*(TDSOLD(IX,IZ)+TDS(IX,IZ))                G2160
  280 NPOLD(IX,IZ)=NPCELL(IX,IZ)                                              G2170
      NPCELL(IX,IZ)=0                                                         G2180
  290 CONTINUE                                                                G2190
C     ***********************************************************************G2200
C        ---COMPUTE CHANGE IN MASS OF SOLUTE STORED---                        G2210
      CSTORM=STORM-STORMI                                                     G2220
      CSTORT=STORT-STORTI                                                     G2230
      SUMIO=FLMIN+FLMOT-CMSIN-CMSOUT                                          G2240
      TDSIO=FLTIN+FLTOT-TDSOUT-TDSIN                                          G2250
C     ***********************************************************************G2260
C     ---REGENERATE PARTICLES IF 'NZCRIT' EXCEEDED---                         G2270
      IF (TEST.GT.98.0) CALL GENPT                                            G2280
      TEST=0.0                                                                G2290
C     ***********************************************************************G2300
C      --- CHECK FOR A SIGNIFICANT CONCENTRATION CHANGE ---                   G2310
      TEST3=0.0                                                               G2320
      DO 300 IX=1,NX                                                          G2330
      DO 300 IZ=1,NZ                                                          G2340
      IF (PERM(IX,IZ).EQ.0.0) GO TO 300                                       G2350
      IF (ABS(TDS(IX,IZ)-CNCHCK(IX,IZ)).GT.CTOL) TEST3=1.0                    G2360
  300 CONTINUE                                                                G2370
      IF (TEST3.EQ.0.0) GO TO 310                                             G2380
C      --- RECALCULATE PRESSURES AND VELOCITIES WITH NEW VALUES ---           G2390
      WRITE (6,390)                                                           G2400
      WRITE (6,380)                                                           G2410
      CALL ITERAT                                                             G2420
      CALL VELO                                                               G2430
      WRITE (6,390)                                                           G2440
C     ***********************************************************************G2450
  310 RETURN                                                                  G2460
C     ***********************************************************************G2470
C                                                                             G2480
C                                                                             G2490
C                                                                             G2500
  320 FORMAT (3H   ,11HTIM(N)    = ,1G12.5,10X,11HTIMV      = ,1G12.5,10X,   G2510
     19HSUMTCH = ,G12.5)                                                      G2520
  330 FORMAT (1HO,5X,40HNUMBER OF CELLS WITH ZERO PARTICLES  =  ,I4,5X,9      G2530
     1HIMOV  =  ,I4/)                                                         G2540
  340 FORMAT (1HO,5X,44H***   NZCRIT EXCEEDED  ---  CALL GENPT   ***/)        G2550
  350 FORMAT (1H ,5X,37H***CONC.GT.0.AND.PERM.EQ.0 AT NODE = ,2I4,4X,7HC      G2560
     1ONC = ,G10.4,4H ***)                                                    G2570
  360 FORMAT (1HO,2X,6HNPCELL/)                                               G2580
  370 FORMAT (1H ,4X,20I3)                                                    G2590
  380 FORMAT (1H ,49HRECALCULATE PRESSURES DUE TO CONCENTRATION CHANGE)       G2600
  390 FORMAT (1H )                                                            G2610
      END                                                                     G2620-
      SUBROUTINE OUTPT                                                        H  10
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                     H  20
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO      H  30
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTMV,NPNTVL,NPNTD,N      H  40
     2PNCHV,NPDELC,ICHK,NCONST                                                H  50
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500),      H  60
     1IXOBS(5),IZOBS(5)                                                       H  70
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24      H  80
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR      H  90
```

```
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),AOPT(20),TITLE(10),ANFCTR,X   H 100
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL      H 110
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24,   H 120
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5,   H 130
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C   H 140
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI   H 150
     4S,DLTRAT,CSTORM,CSTORT,DMOLEC                                        H 160
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VZBDY(24,20),SUMTDS(24,20),   H 170
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)         H 180
      COMMON /DENVIS/ DEN1,DEN2,VIS1,VIS2                                  H 190
      COMMON /BALM/ TOTLQ,TOTLQI,TPIN,TPOUT                                H 200
      DIMENSION IP(24)                                                     H 210
C     ***************************************************************      H 220
      TIMD=SUMT/86400.                                                     H 230
      TIMY=SUMT/(86400.0*365.25)                                           H 240
C     ---PRINT PRESSURE VALUES---                                          H 250
      WRITE (6,90)                                                         H 260
      WRITE (6,100) N                                                      H 270
      WRITE (6,110) SUMT                                                   H 280
      WRITE (6,120) TIMD                                                   H 290
      WRITE (6,130) TIMY                                                   H 300
      WRITE (6,140)                                                        H 310
      DO 10 IZ=1,NZ                                                        H 320
   10 WRITE (6,150) (PK(IX,IZ),IX=1,NX)                                    H 330
      IF (N.EQ.0) GO TO 80                                                 H 340
C     ***************************************************************      H 350
C     ---PRINT PRESSURE MAP---                                             H 360
      WRITE (6,140)                                                        H 370
      WRITE (6,300)                                                        H 380
      WRITE (6,140)                                                        H 390
      DO 30 IZ=1,NZ                                                        H 400
      DO 20 IX=1,NX                                                        H 410
   20 IP(IX)=PK(IX,IZ)+0.5                                                 H 420
   30 WRITE (6,160) (IP(ID),ID=1,NX)                                       H 430
C     ***************************************************************      H 440
C     ---COMPUTE WATER BALANCE AND DRAWDOWN---                             H 450
      QSTR=0.0                                                             H 460
      PUMP=0.0                                                             H 470
      PQIN=0.0                                                             H 480
      PQOUT=0.0                                                            H 490
      TPUM=0.0                                                             H 500
      QIN=0.0                                                              H 510
      QOUT=0.0                                                             H 520
      QNET=0.0                                                             H 530
      DELQ=0.0                                                             H 540
      PCTERR=0.0                                                           H 550
C                                                                          H 560
      DO 60 IZ=1,NZ                                                        H 570
      DO 50 IX=1,NX                                                        H 580
      IP(IX)=0.0                                                           H 590
      IF (PERM(IX,IZ).EQ.0.0) GO TO 50                                     H 600
      IF (REC(IX,IZ).GT.0.0) PQOUT=PQOUT+REC(IX,IZ)*VOL                    H 610
      IF (REC(IX,IZ).LT.0.0) PQIN=PQIN+REC(IX,IZ)*VOL                      H 620
      IF (VPRM(IX,IZ).EQ.0.0) GO TO 40                                     H 630
      DELQC=VPRM(IX,IZ)*VOL                                                H 640
      DENSE=DENS(IX,IZ)                                                    H 650
      IF (PI(IX,IZ).GT.PK(IX,IZ)) DENSE=DEN1*TDSREC(IX,IZ)+DEN2            H 660
```

```
      DELQ=DELQC*(PI(IX,IZ)-PK(IX,IZ)+DENS(IX,IZ)*ELEV(IX,IZ))          H 670
      IF (DELQ.GT.0.0) QIN=QIN+DELQ                                     H 680
      IF (DELQ.LT.0.0) QOUT=QOUT+DELQ                                   H 690
      QNET=QNET+DELQ                                                    H 700
   40 DELP=PI(IX,IZ)-PK(IX,IZ)                                          H 710
      QSTR=QSTR+DELP*VOL*S                                              H 720
   50 CONTINUE                                                          H 730
   60 CONTINUE                                                          H 740
      TPUM=PQOUT+PQIN                                                   H 750
      PUMP=TPOUT+TPIN                                                   H 760
      TOTLQN=TOTLQI+TOTLQ                                               H 770
      SRCS=QSTR-TPIN+TOTLQI                                             H 780
      SINKS=TPOUT-TOTLQ                                                 H 790
      ERRMB=SRCS-SINKS                                                  H 800
      DENOM=(SRCS+SINKS)*0.5                                            H 810
      IF (DENOM.EQ.0.0) GO TO 70                                        H 820
      PCTERR=ERRMB*100.0/DENOM                                          H 830
C        ---PRINT MASS BALANCE DATA FOR FLOW MODEL---                   H 840
   70 WRITE (6,250)                                                     H 850
      WRITE (6,220) TPIN                                                H 860
      WRITE (6,230) TPOUT                                               H 870
      WRITE (6,260) PUMP                                                H 880
      WRITE (6,240) QSTR                                                H 890
      WRITE (6,180) TOTLQI                                              H 900
      WRITE (6,190) TOTLQ                                               H 910
      WRITE (6,270) TOTLQN                                              H 920
      WRITE (6,280) ERRMB                                               H 930
      WRITE (6,290) PCTERR                                              H 940
      WRITE (6,170)                                                     H 950
      WRITE (6,180) QIN                                                 H 960
      WRITE (6,190) QOUT                                                H 970
      WRITE (6,200) QNET                                                H 980
      WRITE (6,220) PQIN                                                H 990
      WRITE (6,230) PQOUT                                               H1000
      WRITE (6,210) TPUM                                                H1010
C     ******************************************************************H1020
   80 RETURN                                                            H1030
C     ******************************************************************H1040
C                                                                       H1050
C                                                                       H1060
C                                                                       H1070
   90 FORMAT (1H1,27HPRESSURE DISTRIBUTION - ROW)                       H1080
  100 FORMAT (1X,23HNUMBER OF TIME STEPS = ,I5)                         H1090
  110 FORMAT (8X,16HTIME(SECONDS) = ,1G12.5)                            H1100
  120 FORMAT (8X,16HTIME(DAYS)    = ,1PE12.5)                           H1110
  130 FORMAT (8X,16HTIME(YEARS)   = ,1PE12.5)                           H1120
  140 FORMAT (1H )                                                      H1130
  150 FORMAT (1H0,10F12.4)                                              H1140
  160 FORMAT (1H0,20I6)                                                 H1150
  170 FORMAT (1H0,2X,33HRATE MASS BALANCE -- (IN C.F.S.) //)            H1160
  180 FORMAT (4X,29HLEAKAGE INTO AQUIFER       = ,1PE12.5)              H1170
  190 FORMAT (4X,29HLEAKAGE OUT OF AQUIFER     = ,1PE12.5)              H1180
  200 FORMAT (4X,29HNET LEAKAGE    (QNET)      = ,1PE12.5)              H1190
  210 FORMAT (4X,29HNET WITHDRAWAL   (TPUM)    = ,1PE12.5)              H1200
  220 FORMAT (4X,29HRECHARGE                   = ,1PE12.5)              H1210
  230 FORMAT (4X,29HDISCHARGE                  = ,1PE12.5)              H1220
  240 FORMAT (4X,29HWATER RELEASE FROM STORAGE = ,1PE12.5)              H1230
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  250 FORMAT (1HO,2X,38HCUMULATIVE MASS BALANCE -- (IN FT**3) //)          H1240
  260 FORMAT (4X,29HCUMULATIVE  NET  RECHARGE  = ,1PE12.5)                H1250
  270 FORMAT (4X,29HCUMULATIVE  NET  LEAKAGE   = ,1PE12.5)                H1260
  280 FORMAT (1HO,7X,25HMASS BALANCE RESIDUAL  = ,G12.5)                  H1270
  290 FORMAT (1H ,7X,25HERROR  (AS PERCENT)    = ,G12.5/)                 H1280
  300 FORMAT (1H ,12HPRESSURE MAP)                                        H1290
      END                                                                 H1300-
      SUBROUTINE CHMOT                                                    I  10
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                 I  20
      COMMON /PRMJ/ NTIM,NPMP,NPNT,NITP,N,NX,NZ,NP,NREC,INT,NNX,NNZ,NUMO  I  30
     1BS,NMOV,IMOV,NPMAX,ITMAX,NZCRIT,IPRNT,NPTPND,NPNTMV,NPNTVL,NPNTD,N  I  40
     2PNCHV,NPDELC,ICHK,NCONST                                            I  50
      COMMON /PRMC/ NODEID(24,20),NPCELL(24,20),NPOLD(24,20),LIMBO(500),  I  60
     1IXOBS(5),IZOBS(5)                                                   I  70
      COMMON /PRESS/ PERM(24,20),PMRX(24,20,4),PI(24,20),PR(24,20),PC(24  I  80
     1,20),PK(24,20),REC(24,20),DENS(24,20),GTERM(24,20),VISC(24,20),VPR  I  90
     2M(24,20),TMWL(5,50),TMOBS(50),TIM(100),AOPT(20),TITLE(10),ANFCTR,X  I 100
     3DEL,ZDEL,WIDTH,S,AREA,SUMT,RHO,PARAM,TEST,TOL,PINT,HMIN,PYR,VOL      I 110
      COMMON /CHMA/ PART(4,6400),CONC(24,20),TDS(24,20),VX(24,20),VZ(24,  I 120
     120),CONINT(24,20),TDSINT(24,20),CNREC(24,20),TDSREC(24,20),TMCN(5,  I 130
     250),TMTDS(5,50),POROS,SUMTCH,BETA,TIMV,STORM,STORT,STORMI,STORTI,C  I 140
     3MSIN,TDSIN,CMSOUT,TDSOUT,FLMIN,FLTIN,FLMOT,FLTOT,SUMIO,TDSIO,CELDI  I 150
     4S,DLTRAT,CSTORM,CSTORT,DMOLEC                                       I 160
      COMMON /CHMC/ SUMC(24,20),VXBDY(24,20),VZBDY(24,20),SUMTDS(24,20),  I 170
     1WTFCTR(24,20),SUMWT(24,20),PTQ(24,20),PTWT(6400),ELEV(24,20)        I 180
      DIMENSION IC(24)                                                    I 190
C     ********************************************************************I 200
      TMFY=86400.0*365.25                                                 I 210
      TMYR=SUMT/TMFY                                                      I 220
      TCHD=SUMTCH/86400.0                                                 I 230
      TCHYR=SUMTCH/TMFY                                                   I 240
      ERR1=0.0                                                            I 250
      ERR3=0.0                                                            I 260
      IF (IPRNT.GT.0) GO TO 180                                           I 270
C     ********************************************************************I 280
C     ---PRINT CONCENTRATIONS---                                          I 290
      WRITE (6,240)                                                       I 300
      WRITE (6,250) N                                                     I 310
      IF (N.GT.0) WRITE (6,260) TIM(N)                                    I 320
      WRITE (6,270) SUMT                                                  I 330
      WRITE (6,550) SUMTCH                                                I 340
      WRITE (6,280) TCHD                                                  I 350
      WRITE (6,290) TMYR                                                  I 360
      WRITE (6,560) TCHYR                                                 I 370
      WRITE (6,480) IMOV                                                  I 380
      WRITE (6,300)                                                       I 390
      IF (NCONST.LT.2) GO TO 30                                           I 400
      WRITE (6,310)                                                       I 410
      DO 20 IZ=1,NZ                                                       I 420
      DO 10 IX=1,NX                                                       I 430
   10 IC(IX)=CONC(IX,IZ)+0.5                                              I 440
   20 WRITE (6,340) (IC(IX),IX=1,NX)                                      I 450
   30 WRITE (6,320)                                                       I 460
      DO 50 IZ=1,NZ                                                       I 470
      DO 40 IX=1,NX                                                       I 480
   40 IC(IX)=TDS(IX,IZ)+0.5                                               I 490
   50 WRITE (6,340) (IC(IX),IX=1,NX)                                      I 500
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C     ******************************************************************      I 510
      IF (N.EQ.0) GO TO 230                                                    I 520
      IF (NPDELC.EQ.0) GO TO 110                                               I 530
C                                                                              I 540
C     ---PRINT CHANGES IN CONCENTRATION---                                     I 550
      WRITE (6,330)                                                            I 560
      WRITE (6,250) N                                                          I 570
      WRITE (6,260) TIM(N)                                                     I 580
      WRITE (6,270) SUMT                                                       I 590
      WRITE (6,550) SUMTCH                                                     I 600
      WRITE (6,280) TCHD                                                       I 610
      WRITE (6,290) TMYR                                                       I 620
      WRITE (6,560) TCHYR                                                      I 630
      WRITE (6,480) IMOV                                                       I 640
      WRITE (6,300)                                                            I 650
      IF (NCONST.LT.2) GO TO 80                                                I 660
      WRITE (6,310)                                                            I 670
      DO 70 IZ=1,NZ                                                            I 680
      DO 60 IX=1,NX                                                            I 690
      CNG=CONC(IX,IZ)-CONINT(IX,IZ)                                            I 700
   60 IC(IX)=CNG                                                               I 710
   70 WRITE (6,340) (IC(IX),IX=1,NX)                                           I 720
   80 WRITE (6,320)                                                            I 730
      DO 100 IZ=1,NZ                                                           I 740
      DO 90 IX=1,NX                                                            I 750
      CNG=TDS(IX,IZ)-TDSINT(IX,IZ)                                             I 760
   90 IC(IX)=CNG                                                               I 770
  100 WRITE (6,340) (IC(IX),IX=1,NX)                                           I 780
C     ******************************************************************      I 790
C     ---PRINT MASS BALANCE DATA FOR SOLUTE---                                 I 800
  110 IF (NCONST.LT.2) GO TO 140                                               I 810
      RESID=SUMIO-CSTORM                                                       I 820
      SUMIN=FLMIN-CMSIN                                                        I 830
      IF (SUMIN.EQ.0.0) GO TO 120                                              I 840
      ERR1=RESID*100.0/SUMIN                                                   I 850
  120 IF (STORMI.EQ.0.0) GO TO 130                                             I 860
      ERR3=-100.0*RESID/(STORMI-SUMIO)                                         I 870
  130 WRITE (6,300)                                                            I 880
      WRITE (6,350)                                                            I 890
      WRITE (6,310)                                                            I 900
      WRITE (6,300)                                                            I 910
      WRITE (6,360) FLMIN                                                      I 920
      WRITE (6,370) FLMOT                                                      I 930
      RECIN=-CMSIN                                                             I 940
      RECOUT=-CMSOUT                                                           I 950
      WRITE (6,390) RECIN                                                      I 960
      WRITE (6,380) RECOUT                                                     I 970
      WRITE (6,400) SUMIO                                                      I 980
      WRITE (6,410) STORMI                                                     I 990
      WRITE (6,420) STORM                                                      I1000
      WRITE (6,430) CSTORM                                                     I1010
      WRITE (6,440)                                                            I1020
      WRITE (6,450) RESID                                                      I1030
      WRITE (6,460) ERR1                                                       I1040
      IF (STORMI.EQ.0.0) GO TO 140                                             I1050
      WRITE (6,470)                                                            I1060
      WRITE (6,460) ERR3                                                       I1070
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C     ******************************************************************     I1080
C     --- PRINT MASS BALANCE FOR TDS ---                                     I1090
  140 RESID=TDSIO-CSTORT                                                     I1100
      SUMIN=FLTIN-TDSIN                                                      I1110
      IF (SUMIN.EQ.0.0) GO TO 150                                            I1120
      ERR1=RESID*100.0/SUMIN                                                 I1130
  150 IF (STORTI.EQ.0.0) GO TO 160                                           I1140
      ERR3=100.0*RESID/(STORTI-TDSIO)                                        I1150
  160 WRITE (6,300)                                                          I1160
      WRITE (6,350)                                                          I1170
      WRITE (6,320)                                                          I1180
      WRITE (6,300)                                                          I1190
      WRITE (6,360) FLTIN                                                    I1200
      WRITE (6,370) FLTOT                                                    I1210
      WRITE (6,390) -TDSIN                                                   I1220
      WRITE (6,380) -TDSOUT                                                  I1230
      WRITE (6,400) TDSIO                                                    I1240
      WRITE (6,410) STORTI                                                   I1250
      WRITE (6,420) STORT                                                    I1260
      WRITE (6,430) CSTORT                                                   I1270
      WRITE (6,440)                                                          I1280
      WRITE (6,450) RESID                                                    I1290
      WRITE (6,460) ERR1                                                     I1300
      IF (STORTI.EQ.0.0) GO TO 170                                           I1310
      WRITE (6,470)                                                          I1320
      WRITE (6,460) ERR3                                                     I1330
C     ******************************************************************     I1340
C     ---PRINT HYDROGRAPHS AFTER 50 STEPS OR END OF SIMULATION---            I1350
  170 IF (MOD(IMOV,50).EQ.0.AND.S.EQ.0.0) GO TO 180                          I1360
      IF (MOD(N,50).EQ.0.AND.S.GT.0.0) GO TO 180                             I1370
      IF (S.EQ.0.0.AND.N.LT.NTIM.AND.INT.GT.0) GO TO 180                     I1380
      GO TO 230                                                              I1390
  180 WRITE (6,490) TITLE                                                    I1400
      IF (NUMOBS.LE.0) GO TO 230                                             I1410
      WRITE (6,500) INT                                                      I1420
      IF (S.GT.0.0) WRITE (6,510)                                            I1430
      IF (S.EQ.0.0) WRITE (6,520)                                            I1440
C        ---TABULATE HYDROGRAPH DATA---                                      I1450
      MOZ=0                                                                  I1460
      IF (S.GT.0.0) GO TO 190                                                I1470
      NTO=NMOV                                                               I1480
      IF (NMOV.GT.50) NTO=MOD(IMOV,50)                                       I1490
      GO TO 200                                                              I1500
  190 NTO=NTIM                                                               I1510
      IF (NTIM.GT.50) NTO=MOD(N,50)                                          I1520
  200 IF (NTO.EQ.0) NTO=50                                                   I1530
      DO 220 J=1,NUMOBS                                                      I1540
      TMYR=0.0                                                               I1550
      WRITE (6,530) J,IXOBS(J),IZOBS(J)                                      I1560
      WRITE (6,540) MOZ,PI(IXOBS(J),IZOBS(J)),CONINT(IXOBS(J),IZOBS(J)),     I1570
     1TDSINT(IXOBS(J),IZOBS(J)),TMYR                                         I1580
      DO 210 M=1,NTO                                                         I1590
      TMYR=TMOBS(M)/TMFY                                                     I1600
  210 WRITE (6,540) M,TMWL(J,M),TMCN(J,M),TMTDS(J,M),TMYR                    I1610
  220 CONTINUE                                                               I1620
C     ******************************************************************     I1630
  230 IPRNT=0                                                                I1640
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      RETURN                                                                I1650
C     ***********************************************************************I1660
C                                                                           I1670
C                                                                           I1680
C                                                                           I1690
  240 FORMAT (1H1,13HCONCENTRATION/)                                        I1700
  250 FORMAT (1X,23HNUMBER OF TIME STEPS = ,1I5)                            I1710
  260 FORMAT (8X,16HDELTA T        = ,1G12.5)                               I1720
  270 FORMAT (8X,16HTIME(SECONDS) = ,1G12.5)                                I1730
  280 FORMAT (3X,21HCHEM.TIME(DAYS)     = ,1E12.5)                          I1740
  290 FORMAT (8X,16HTIME(YEARS)    = ,1E12.5)                               I1750
  300 FORMAT (1H )                                                          I1760
  310 FORMAT (1H ,15X,12HTRACE SOLUTE)                                      I1770
  320 FORMAT (1H0,15X,26HDENSITY-CONTROLLING SOLUTE)                        I1780
  330 FORMAT (1H1,23HCHANGE IN CONCENTRATION/)                              I1790
  340 FORMAT (1H0,20I5)                                                     I1800
  350 FORMAT (1H ,21HCHEMICAL MASS BALANCE)                                 I1810
  360 FORMAT (8X,25HMASS IN BOUNDARIES      = ,1PE12.5)                     I1820
  370 FORMAT (8X,25HMASS OUT BOUNDARIES     = ,1PE12.5)                     I1830
  380 FORMAT (8X,25HMASS PUMPED OUT         = ,1PE12.5)                     I1840
  390 FORMAT (8X,25HMASS PUMPED IN          = ,1PE12.5)                     I1850
  400 FORMAT (8X,25HINFLOW MINUS OUTFLOW    = ,1PE12.5)                     I1860
  410 FORMAT (8X,25HINITIAL MASS STORED     = ,1PE12.5)                     I1870
  420 FORMAT (8X,25HPRESENT MASS STORED     = ,1PE12.5)                     I1880
  430 FORMAT (8X,25HCHANGE MASS STORED      = ,1PE12.5)                     I1890
  440 FORMAT (1H ,5X,53HCOMPARE RESIDUAL WITH NET FLUX AND MASS ACCUMULA    I1900
     1TION:)                                                                I1910
  450 FORMAT (8X,25HMASS BALANCE RESIDUAL   = ,1PE12.5)                     I1920
  460 FORMAT (8X,25HERROR  (AS PERCENT)     = ,1PE12.5)                     I1930
  470 FORMAT (1H ,5X,55HCOMPARE INITIAL MASS STORED WITH CHANGE IN MASS     I1940
     1STORED:)                                                              I1950
  480 FORMAT (1X,23H NO. MOVES COMPLETED = ,1I5)                            I1960
  490 FORMAT (1H1,10A8//)                                                   I1970
  500 FORMAT (1H0,5X,65HTIME VERSUS HEAD AND CONCENTRATION AT SELECTED O    I1980
     18SERVATION POINTS//15X,19HPUMPING PERIOD NO. ,I4////)                 I1990
  510 FORMAT (1H0,16X,19HTRANSIENT  SOLUTION////)                           I2000
  520 FORMAT (1H0,15X,21HSTEADY-STATE SOLUTION////)                         I2010
  530 FORMAT (1H0,20X,22HOBS.WELL NO.     X     Z,17X,1HN,6X,64HPRESSURE (  I2020
     1LB/FT**2)   CONC.(MG/L)  TDS (MG/L)      TIME (YEARS)  //24X,I3,9X,   I2030
     2I2,3X,I2//)                                                           I2040
  540 FORMAT (1H ,58X,I2,12X,F7.1,8X,F7.1,8X,F7.1,8X,F7.3)                  I2050
  550 FORMAT (1H ,2X,21HCHEM.TIME(SECONDS) = ,1PE12.5)                      I2060
  560 FORMAT (1H ,2X,21HCHEM.TIME(YEARS)   = ,1PE12.5)                      I2070
      END                                                                   I2080-
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